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PHYSICS ABSTRACTS

SECTION A

of

SCIENCE ABSTRACTS

SECTION A, PHYSICS

SECTION B, ELECTRICAL ENGINEERING

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INSTITUTE OF ELECTRICAL ENGINEERS

ABSTRACTS 1558–2290

OLUME 54 **MARCH 1951** NUMBER 639

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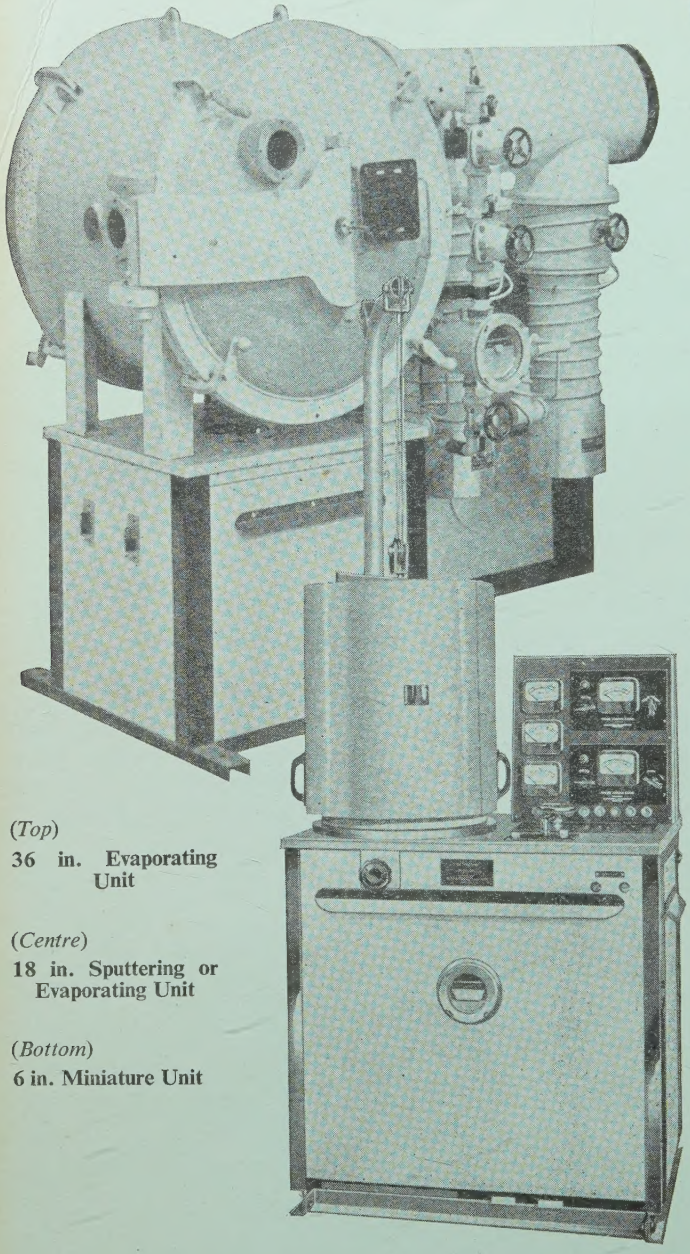

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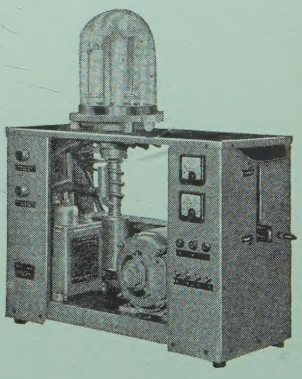

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Principal Contents

MARCH 1951

		PAGE
51	MATHEMATICS	177
52	ASTRONOMY. ASTRO-PHYSICS. GEODESY	178
53	PHYSICS	181
530.1	Fundamentals	182
531	General mechanics. Mechanics of solids	185
531.7	Mechanical measurements	186
532	Mechanics of fluids	186
532.6	Capillarity	—
532.7	Molecular theory of liquids	188
533	Mechanics of gases	189
533.7	Molecular theory of gases	190
534	Vibrations. Acoustics	190
535	Optics. Radiation. Spectra	196
536	Heat	205
536.7/.8	Thermodynamics	208
537	Electricity	208
537.1	Theory. Electrons	208
537.2	Electrostatics. Dielectrics	209
537.3	Electric conduction. Currents	209
537.52	Electric discharges	214
537.531	X-rays	215
537.533/.534	Cathode rays. Positive rays	215
537.54	Discharge tubes. Counters	216
537.56/.58	Ionization. Thermionics	217
537.591	Cosmic rays	218
538	Magnetism	221
538.3/.5	Electromagnetism. Electrodynamics	224
538.56	Electromagnetic waves and oscillators	224
538.6	Magnetic effects	225
539.1	Molecular and atomic structure	226
539.11	Theory of solid state	226
539.13	Molecular structure	226
539.15	Atomic structure. Nucleus. Isotopes	227
539.16	Radioactivity. α-, β- and γ-rays	229
539.17	Nuclear reactions	233
539.18	Atom and molecule beams. Mesons. Neutrons	237
539.2	Structure of solids	238
539.3/.8	Elasticity. Strength. Rheology	239
541	PHYSICAL CHEMISTRY	243
541.11/.12	Phase equilibrium. Chemical reactions	243
541.13	Electrochemistry	245
541.14	Photochemistry. Radiation chemistry	245
541.18	Dispersions. Colloids. Adsorption	246
541.4/.6	Chemical structure	247
542.1/.7	Laboratory apparatus	247
543/545	Chemical analysis	248
548	CRYSTALLOGRAPHY	249
548.7	Molecular and X-ray crystallography	249
55	GEOPHYSICS	253
551.5	Atmosphere. Meteorology	253
57/59	BIOLOGY	258
61	Medical science. Human physiology	258
66/67	TECHNICAL MATERIALS	261
77	PHOTOGRAPHY	262

RELATED SUBJECTS CONTAINED IN SECTION B (ELECTRICAL ENGINEERING ABSTRACTS)

Mechanical testing
Non-destructive testing
Industrial radiography
Electrical and magnetic measurements and instruments
Electronic relays and counters
Automatic control mechanisms
Applied electrochemistry
Photocells
Thermionic tubes
Cathode-ray tubes
X-ray tubes
Amplifiers
Radiocommunication
Mechanical engineering
Illumination
Metallurgy

LIST OF JOURNALS

The following list supplements the List of Journals published with the January number of Volume 53 (1950) and the Supplement published with the Index to Volume 53 (1950). Reprints of the List of Journals (1950) and the Supplement (1950) can be obtained from The Institution of Electrical Engineers, Savoy Place, London, W.C.2, price 2s. post free.

The addresses given are believed to be correct at the date of publication, but no responsibility can be accepted for errors.

Journals marked * are not received regularly.

Bull. Earthquake Res. Inst., Tokyo	*Bulletin of the Earthquake Research Institute.* The University, Tokyo.
Commun. Fac. Sci. Univ. d'Ankara	*Communications de la Faculté des Sciences de l'Université d'Ankara.* [Foreign language edition of *Ankara Universitesi Fen Fakultesi Mecmuasi*]. Ankara.
Dtsch. Akad. Wiss. Berlin, Veröff. Geodät. Inst. Potsdam	*Deutsche Akademie der Wissenschaften zu Berlin. Veröffentlichungen des Geodätischen Institutes in Potsdam.* Potsdam.
Elektron	*Das Elektron in Wissenschaft und Technik.* Daimlerstrasse 5, Munich 13.
Engng Rep. Nat. Tsing Hua Univ.	*Engineering Reports of National Tsing Hua University.* Peiping, China.
Fuel	*Fuel.* Butterworths Scientific Publications, 19–23 Ludgate Hill, London, E.C.4. [Change of address.]
J. Atmos. Terr. Phys.	*Journal of Atmospheric and Terrestrial Physics.* Butterworths Scientific Publications, 19–23 Ludgate Hill, London, E.C.4. [Change of address.]
J. Soc. Appl. Mech. Japan	*Journal of the Society of Applied Mechanics of Japan.* Post Restante, Box No. 24, Shibaya Post Office, Tokyo. [Change of address.]
**Nat. Verd., Copenhagen*	*Naturens Verden.* Gyldendalske Boghandel, Nordisk Forlag, Copenhagen.
Prom. Energ.	*Promyshlennaya energetika.* Vetoshnyĭ per., Gum III–ĭ, Korpus, Moscow.
Publ. Roy. Obs., Edinburgh	*Publications of the Royal Observatory.* Edinburgh.
Rep. Mech. Lab., Tokyo	*Report of the Mechanical Laboratory.* The Government Mechanical Laboratory, The Agency of Industrial Science and Technology, Sumiyoshicho, Sunginami-ku, Tokyo.
Research, Lond.	*Research.* Butterworths Scientific Publications, 19–23 Ludgate Hill, London, E.C.4. [Change of address.]
Spectrochim. Acta	*Spectrochimica Acta.* Butterworth–Springer, 19–23 Ludgate Hill, London, E.C.4. [Change of address.]
Trans. Instrum. Meas. Conf., Stockholm (1949)	*Transactions of the Instruments and Measurements Conference, Stockholm* (1949). The Royal Swedish Academy of Engineering Sciences, Box 5073, Stockholm 5.

NEW JOURNAL

**Elettrificazione*	*Elettrificazione.* Via Pace N.19, Milan. Monthly. First number dated December, 1950. Subscription: Italy, L.3,500; Foreign, L.7,000.

ABSTRACTING JOURNAL

British Society of Rheology	[Formerly British Rheologists' Club.] Lyndhurst, Links Way, Little Bookham, Leatherhead, Surrey.

MATHEMATICS 51

512.831

1558. Determination of the proper values and directions of a matrix. M. MAYOT. *Ann. Astrophys.*, **13**, 282–93 (*July–Sept.*, 1950) *In French.*

By successive substitutions, the set of equations $\sum_{j=1}^{n} a_{ij}x_j = \lambda x_i$, $i = 1, 2, \ldots, n$, is reduced to the form $\lambda X_i = X_{i+1}$, $i = 1, 2, \ldots, n-1$, $\lambda X_n = \sum_{r=1}^{n} p_r X_{n+1-r}$. This is used as the basis of a scheme for the numerical calculation of the characteristic values λ and the corresponding characteristic directions $(x_1, x_2, \ldots, x_n)$ of the square matrix $[a_{ij}]$. R. A. NEWING

517.43

1559. The remainder theorem and its application to operational calculus techniques. A. S. RICHARDSON, JR. *Proc. Inst. Radio Engrs*, **38**, 1336–9 (*Nov.*, 1950).

The necessary procedure involved in the transition from the Laplace transformation to the solution of linear differential equations is summarized, and a particular form of partial-fraction expansion which may be advantageous in special cases is noted. The remainder theorem with regard to algebraic polynomials is restated, and it is shown how this theorem may be applied to the evaluation of high-degree polynomials for real and complex numbers. A numerical example is treated to illustrate application to a typical transfer function. Finally, the method is shown to be useful in the evaluation of the frequency response of such a transfer function. A.

517.52 : 530.145

1560. Asymptotic expansion of irregular Coulomb function for angular momentum zero. G. BREIT AND M. H. HULL, JR. *Phys. Rev.*, **80**, 392–5 (*Nov.* 1, 1950).

A justification is given for an expansion of the irregular Coulomb function, usually denoted by G_0, in terms of Bessel functions of the second kind with an imaginary argument. This expansion has been considered speculatively by Yost, Wheeler, and Breit and explicitly verified by Breit and Bouricius for a number of terms. A general rule of replacement of the Bessel functions of the first kind with an imaginary argument in the corresponding expansion of the regular Coulomb function is here established. The formulae developed are convenient for the calculation of coefficients of the energy. A.

517.63

1561. The Mellin transform and its applications. P.-A. BARRUCAND. *Ann. Télécomm.*, **5**, 381–8 (*Nov.*, 1950) *In French.*

The transform may be useful in various physical problems, e.g. potential problems or problems involving integro-differential equations. Various mathematical properties of the transform are developed, and its use in evaluating integrals is illustrated. A comprehensive list of transforms is given. L. S. GODDARD

517.9

1562. A process for the step-by-step integration of differential equations in an automatic digital computing machine. S. GILL. *Proc. Camb. Phil. Soc.*, **47** (*Pt I*) 96–108 (1951).

It is advantageous in automatic computers to employ methods of integration which do not require preceding function values to be known. From a general theory given by Kutta, one such process is chosen giving fourth-order accuracy and requiring the minimum number of storage registers. It is developed into a form which gives the highest attainable accuracy and can be carried out by comparatively few instructions. The errors are studied and a simple example is given. A.

517.941.9

1563. Numerical determination of characteristic numbers. W. E. MILNE. *J. Res. Nat. Bur. Stand., Wash.*, **45**, 245–54 (*Sept.*, 1950).

A contribution to the problem of characteristic values and characteristic solutions of ordinary linear differential equations. The problem is conceived as a vibration problem in x and t. The partial differential equation is then approximated by a difference equation in both entries. The problem is now to find those frequencies in which a separation in x and t takes place. This is done by finding the roots of a trigonometric expansion of certain order. The method is applied to a number of interesting cases that illustrate various types of situations encountered in problems of physics and engineering. A.

518.5

1564. The arithmetical unit in a mathematical machine. G. NEOVIUS. *Tele, No.* 2, 63–72 (1950) *In Swedish.*

Reprint of article in *Svenska Fysikersamfundets Årsbok* "*Kosmos*," surveying computing machines. BARK, the Swedish relay machine, handles numbers of 24 binary digits. A separate group indicates the position of the binary point, so that the first 24 digits of a 48 digit product are always obtained. In BARK the multiplication time is reduced by converting to the scale of 8, writing the 24 digit number as 8 groups of 3 binary digits. The total multiplication time is 4 relay operating times. H. JEFFERSON

518.5

1565. VENDAC—a Venn diagram analogue computer. A. I. ARCHER. *S. Afr. J. Sci.*, **47**, 133–40 (*Dec.*, 1950).

The manner in which an electronic analogue computer for the Boolean algebra can be derived in terms of coded electrical pulses is described. It is likely that the technique could be extended to yield a computer for numerical problems in the algebra of classes and statistics. A.

518.5

1566. A Venn diagram analogue computer. A. ARCHER. Letter in *Nature, Lond.*, **166**, 829 (*Nov.* 11, 1950).

518.5 : 621.317.39

1567. The mechanical differential analyser at the Chalmers' Institute of Technology—a mathematical machine at the disposal of technical and natural science research. S. EKELÖF AND B. LUNDQUIST. *Iva, Stockholm*, **21** (*No.* 4) 145–53 (1950) *In Swedish.*

A mechanical differential analyser of the Bush type with 4 integrators, presenting some novel features, has recently been completed. The machine uses 6 mm shafts, set up in spherical ball-bearings in a vertical frame. The small size and vertical construction yield an easily accessible machine with a clear survey of the problem set-up, occupying small floor-space and with light and easily handled units. The integrators, designed by the Ericsson Telephone Co., have two vertical wheels, pressed against a horizontal disc. Their output torque is so large that torque amplifiers are unnecessary. The machine has one single and one double table which can serve both as input and output tables. Back-lash eliminating units are not used. The best accuracy obtainable is about $\frac{1}{2}\%$. Two problems already treated on the machine are briefly discussed.

A.

519.27 : 531.719.24

Distribution of range-finding errors. *See Abstr.* 1633

ASTRONOMY . ASTROPHYSICS . GEODESY 52

521.030 : 530.145

1568. Quantum mechanics and astrophysics. W. H. MCCREA. *Nature, Lond.*, **166**, 884–6 (*Nov.* 25, 1950).

Various astrophysical applications of quantum mechanics are reviewed, and the significance of astrophysical phenomena in the future development of fundamental physical theory is discussed. Attention is drawn to problems that may require new physical conceptions, and the importance of continuous creation theories is indicated. R. A. NEWING

521.1

1569. On revising the official system of astronomical constants. G. M. CLEMENCE. *Bull. Astron., Paris*, **15** (*No.* 3) 181–90 (1950).

The following recommendations are made: the fundamental unit of time to be employed in all cases when the mean solar second of the date is unsatisfactory by reason of its variability, is the mean solar second of 1900; the astronomical unit is defined as the unit in which a is derived from the relation $a^3n^2 = k^2(1 + m)$, m being the mass of a planet (including satellites, if any) expressed in units of the sun's mass, k the Gaussian constant 0·01720209895 precisely, and n the angular sidereal motion of the planet expressed in radians per mean solar day (the mean solar day employed is composed of 86 400 mean solar seconds of 1900); the constant of the solar parallax is defined as the angle subtended by the earth's mean equatorial radius at a distance of one astronomical unit. A. BEER

521.1

1570. The system of astronomical constants. H. SPENCER JONES. *Bull. Astron., Paris*, **15** (*No.* 4) 247–63 (1950).

A general discussion of the basis, reliability and internal consistency of the system at present adopted, and the desirability of a new derivation.

M. W. OVENDEN

521.1 : 512.831

1571. Some applications of matrices in celestial mechanics. G. M. BAZHENOV. *Bull. Inst. Theor. Astron.*, **4**, 143–68 (1949) *In Russian.*

Matrices, or rather a modification known as Cracovians, were introduced for the first time into celestial mechanics by Banachiewicz in order to simplify certain laborious computing schemes. The present paper deals with some applications of matrices which are primarily connected with transformations of various differential equations. The author treats the following topics: definitions and some general statements; matrices of rotation; general transformation of co-ordinates with constant origin of co-ordinates; matrices for precession; differential equations of the limited problem of three bodies; deduction of differential equations for the perturbed elements of the orbit; canonical elements; improvement of orbits; scheme for computing perturbed elements.

ASTRONOMICAL NEWS LETTER

521.1 : 523.11

1572. *n*-body problems in celestial mechanics and cosmogony. G. F. KHILMI. *Izv. Akad. Nauk, SSSR, Ser. Fiz.*, **14** (*No.* 1) 46–50 (1950) *In Russian.*

The problem is considered to have 2 main subdivisions: (1) the question of the conditions producing a system of gravitational bodies which will be stable, semi-stable or fully susceptible of dissipation; (2) the question of the combination of the latter regime for one direction of time with a fully stable regime for the other direction. As to (1) it is shown mathematically that under certain conditions the presence of a large number of rapidly dissipating bodies can lead to the formation of a stable section within the system. As to (2) evidence is advanced against the usual supposition of sidereal mechanics that sidereal systems rapidly approach a statistically stationary condition. Accordingly, variations from such a condition cannot be considered conclusive proof of the relatively recent origin of any sidereal system. J. CLEUGH

521.12 : 531.35

1573. The motions of a material particle under the force which produces an acceleration $-\mu_1 r^{-2} - 3\mu_2 r^{-4}$. S. D. TSCHERNY. *Bull. Inst. Theor. Astron.*, **4**, 287–308 (1949) *In Russian.*

The problem is encountered in investigations of motions of satellites around an ellipsoidal planet, also in motions of close doubles and in the motion of a planet around the sun in the general theory of relativity. The introduction summarizes previous investigations, listed at the end of the paper. The author thinks that in spite of the fact that many have tried to solve the problem, as yet no solution well suited for practical application has been found. The

present work is subdivided into five parts: the general equation of an orbit and a generalized Kepler equation for the case when $u_1 < u < u_2$; the motion of a point when μ_2 tends towards zero; the orbit for the case when $u_3 < u < \infty$; geometric properties of the orbit; periplegmatic orbits of Gylden.

ASTRONOMICAL NEWS LETTER

522.3

1574. The heliomeridianscope. G. VINACCIA. *Atti Accad. Naz. Lincei* (*R.C. Cl. Sci. Fis. Mat. Nat.*) **9**, 72–9 (*July–Aug.*, 1950) *In Italian.*

This is a new instrument for use in celestial topography as well as in practical geodesy. The direction of the geographical meridian can be ascertained by simple means and high accuracy from anywhere on the surface of the earth. The heliomeridianscope is based on two principles of spherical astronomy, namely that for equal arcs (in hours), the apparent ante- and post-meridian position of the sun is symmetrical to the meridian and has equal height and azimuth, and that the sun culminates on its passage through the meridian. The instrument consists of five parts which are described in detail, as is also the operation. W. SUMMER

523.165 : 523.72 : 523.855

1575. Solar and galactic radio noise. *U.R.S.I. Spec. Rep. No.* 1, 47 *pp.* (1950).

A report of a sub-commission under the chairmanship of E. Appleton, surveying the whole of the theoretical and experimental work on this subject up to 1950. No discussion of experimental techniques for the observation of extra-terrestrial noise is given. The first section of the report reviews the theory of radio noise and the conception of equivalent aerial temperature. The second section discusses solar noise and concludes that bursts of intense solar radiations are associated with sunspots and that the thermal solar noise corresponds to much higher temperatures than 6 000°K for certain wavelengths. The various theories advanced to explain these effects are discussed. In the final section galactic noise is considered and the two chief sources are found to lie in Cygnus and Sagittarius. Further experimental work has shown that some of the sources of galactic noise are of small angular size and can be identified with certain nebulous objects. The theories put forward to explain these effects are compared and it appears that a satisfactory theoretical explanation has not yet been found. There is a bibliography of 78 papers. J. M. HOUGH

523.165 : 523.855

1576. Radio-frequency radiation from the great nebula in Andromeda (M.31). R. H. BROWN AND C. HAZARD. Letter in *Nature, Lond.*, **166**, 901–2 (*Nov.* 25, 1950).

Brief account of some galactic noise measurements on a frequency of 158·5 Mc/s. It is concluded that "these measurements demonstrate with a high degree of probability that extra-galactic r.f. radiation is being received on the earth from the great nebula in Andromeda, and that, so far as radio emission is concerned, it appears to be similar to our own galaxy." W. J. G. BEYNON

523.165 : 537.591

1577. Electromagnetic waves emitted by fast protons in strong magnetic fields, and the relation between cosmic rays and the radio frequency noise of the sun and Galaxy. B. KWAL. *C.R. Acad. Sci., Paris*, **231**, 1057–9 (*Nov.* 13, 1950) *In French.*

Theoretical. According to classical theory, a proton of 10^9 to 10^{10} eV emits strongly in the m and cm bands. The acceleration of cosmic rays in the fields of sunspots and "star-spots" is considered as a possible source of the observed r.f. background. E. P. GEORGE

523.2

1578. The origin of planets and their satellites. O. YU. SHMIDT. *Izv. Akad. Nauk, SSSR, Ser. Fiz.*, **14** (*No.* 1) 29–45 (1950) *In Russian.*

The origin of the earth and the planets is here regarded as one complex problem, the solution of which must take account of the facts of geophysics, geology and geochemistry, as well as those of planetary astronomy. The known main features of the planetary system are summarized, origin of the solar cluster not being considered. Expressions are formulated for the laws governing the planetary intervals and it is shown that the square roots of the distances of planets from the sun establish an arithmetical progression. The course of axial rotation of the planets is shown to have a close connection with the formation of satellites and mathematical evidence is advanced for (*a*) the theory that such rotation is a collateral result of the formation of planets from meteor fragmentation; (*b*) the conditions upon which rotation in one direction or the other depends; (*c*) the presence in the same cluster of conditions favouring rotation in one direction. The origin of the satellites is referred to a similar balance of energy and moment. Distant planets are shown to rotate inversely, the radius of orbit not exceeding the size of the planet. An hypothesis of the sun's formation, through the capture of igneous (meteoric) particles by an igneous cloud in the galaxy, indicates the earth's origin by a cooling process, the structure being subsequently warmed by radioactivity. J. CLEUGH

523.34

1579. Nature of the surface of the moon. J. C. JAEGER AND A. F. A. HARPER. Letter in *Nature, Lond.*, **166**, 1026 (*Dec.* 16, 1950).

It is shown that the i.r. observations of lunar temperature during eclipse by Pettit [*Astrophys. J.*, **91**, 408 (1940)] are inconsistent with a lunar surface of homogeneous material whose thermal conductivity is independent of temperature. It has not been found possible to reproduce the observations with any reasonable variation of thermal conductivity with temperature. A model of a thin dust layer lying above a homogeneous substratum is examined, and best fit is obtained for a layer of dust about 2 mm thick lying above a substratum whose thermal properties resemble those of terrestrial pumice or gravel. M. W. OVENDEN

523.43

1580. The structure and chemical composition of Mars. H. C. UREY. Letter in *Phys. Rev.*, **80**, 295 (*Oct.* 15, 1950).

523.72

1581. The inversion of Laplace's relation. J.-C. PECKER. *C.R. Acad. Sci., Paris*, **231**, 947–9 (*Nov.* 6, 1950) *In French.*

An electrical circuit is devised for the automatic solution of this problem in solar radiation, which could hitherto only be attacked by involved numerical methods. A. BEER

523.74 : 550.386

1582. Solar flares and moderate geomagnetic activity. O. R. WULF AND S. B. NICHOLSON. *Publ. Astron. Soc. Pacif.*, **62**, 202–10 (*Oct.*, 1950).

The authors suggest that an improved solar index of moderate geomagnetic activity can be devised combining all known features leading to changes in solar u.v. radiation, such as bright Ca flocculi appearing on the E limb or developing on the disc, and solar flares of all magnitudes. It is suggested that u.v. radiation need not be variable in order to cause geomagnetic activity but that when it varies it may cause the principal air motions in the lower ionosphere causing increased geomagnetic activity. It is also suggested that an alternative explanation of the lag of geomagnetic activity with respect to sun-spottedness may be the result of a "fatigue" of the ionosphere.
V. C. A. FERRARO

523.82

1583. On the distribution of stellar luminosities among the nearer stars, and connected notes. A. DANJON AND P. COUDERC. *Ann. Astrophys.*, **13**, 211–18 (*July–Sept.*, 1950) *In French.*

The question whether the absolute magnitudes M follow a Laplace–Gaussian distribution is examined afresh, and the conclusion is reached that they do not. The authors show that the number $N(M)$ for the near stars increases until $M_{vis} = 15^m$. Furthermore, it is shown that in the neighbourhood of the sun less than 1/3 of the local galactic density is accounted for by dark bodies and interstellar matter, while the stars contribute $4{\cdot}3 \times 10^{-24}$ g/cm³ of the mean density $6{\cdot}3 \times 10^{-24}$ g/cm³ (Oort). Finally, statistical data for the 100 nearest stars are given for the relative abundance of double star components, white dwarfs, and "red dwarfs" (having spectra later than K0); the last two groups together represent more than 90%.
A. BEER

523.85

1584. Sidereal associations and the origin of stars. V. A. AMBARTSUMYAN. *Izv. Akad. Nauk, SSSR, Ser. Fiz.*, **14** (*No.* 1) 15–24 (1950) *In Russian.*

The density of an association of giant igneous stars (e.g. spectral type O) being lower than that of the galaxy containing it, it is argued that such O stars cannot be stationary but must be in process of disintegration from recent organization. This consideration leads to the theory that stars originate in galactic associations and separate sub-groups within such associations. Any sidereal accumulation containing among its brightest stars a multiple system of the Orion's Table or chain type is hence regarded as the core of some kind of association and conversely the core of any kind of association must contain such a system. The thesis is illustrated by reproductions of photographs: two sidereal accumulations in th constellation of Auriga; a sidereal accumulation i Cassiopeia; sidereal accumulations *h* and *Z* in Perseu showing in one of them two multiple systems of th Orion's Table type; a sidereal accumulation (M2 with a system divided into two parts by a "corridor J. CLEUG

523.8

1585. A note on sidereal associations. G. A. SHAI *Izv. Akad. Nauk, SSSR, Ser. Fiz.*, **14** (*No.* 1) 25– (1950) *In Russian.*

Immediately follows V. A. Ambartsumyan's artic (see preceding Abstr.) and comments on it, adducin the further consideration that a diffused nebu near a star or star-group and reflecting or stimulate by its light may have a certain contour of vague circular aspect. It is argued that this phenomenc cannot be an accident but must indicate a genet relation between the nebula and the star-group, sinc the former was either the result of a recent viole evolutionary process detaching some portion of th sidereal mass or else both nebula and star-group we formed by a process which is still unknown to but probably bears some relation to that whic appears to originate stars. J. CLEUG

523.85

1586. A photometric study of nearby galaxie E. HOLMBERG. *Lunds Univ. Arsskr., Avd.* 2, **46** (*No.* 5–56 (1950) [Also publ. as *Medd. Lunds Astro Obs., Ser. II, No.* 128].

The observational material consists of 168 individu magnitudes (obtained from photographs with th Mount Wilson 60 in, and the Hamburg 60 cm ar 100 cm reflectors) of 39 galaxies belonging to th local group and the groups associated with M 81 ar M 101. A critical discussion is given of the metho of photometry, and of the selection of the materi to be truly representative of a given volume of spac A mean error of one plate of 0·056 is indicate total luminosities being about 1 m brighter than tho given by the Shapley–Ames catalogue. Frequenc distributions in both absolute luminosities an dimensions are markedly skew in the sense of exce small and faint systems. A correlation betwee total magnitude of nebula (M_t) and magnitude brightest resolved stars (M_s) given by $M_s = 0{\cdot}60\, M_t$ 2·4 is revealed, the constant term depending som what upon the type of nebula. Similar relationshi are found for stellar populations in spheres of differe radii round the sun and for open galactic cluster a theoretical analysis indicating that such correlatio may be entirely explained by statistical selection.
M. W. OVENDE

523.87

1587. On the luminosity function of type I star E. HOLMBERG. *K. Fysiogr. Sällsk. Lund, Förh.*, 2 (*No.* 18) 13 *pp.* (1950).

The luminosity functions of stars in IC 161 NGC 6822, and NGC 598 have been determined b means of extrapolations based on the observe magnitude distributions of resolved stars and on th integrated magnitudes of the systems, as derived b the writer. The luminosity curves agree rather close

with the curve valid for stars in the solar neighbourhood. The mean curve has been used to determine the ratio of type I to type II stars in the Andromeda nebula, and to investigate the relation between magnitudes of brightest resolved stars and total magnitudes of nebulae. A.

523.877

1588. Contribution to the theory of spectral type. I. General introduction: The construction of model atmospheres. J.-C. PECKER. *Ann. Astrophys.*, **13**, 294–318 (*July–Sept.*, 1950) *In French.*

With the assumptions of radiative, local thermodynamic and hydrostatic equilibrium, equations are established which describe conditions within a stellar atmosphere for the general case of arbitrary laws of absorption and scattering of radiation. The methods of solution of Chandrasekhar and of Kourganoff for the grey-body case are briefly described, and discussed. The methods of various authors (Chandrasekhar, Kourganoff, Strömgren) for the general case are discussed in detail. The tables of Kourganoff and of Strömgren for the calculation of flux and mean intensity are extended for the calculation of radiation pressure. M. W. OVENDEN

523.877

1589. Contribution to the theory of spectral type. II. The polarization by free electrons and spectral type. J.-C. PECKER. *Ann. Astrophys.*, **13**, 319–36 (*July–Sept.*, 1950) *In French.*

Polarization by free electrons is examined by Chandrasekhar's methods for the case $\lambda = \sigma/(\sigma + \bar{x})$ independent of optical depth, and also for λ varying discontinuously through a series of constant values. The results are applied numerically to the solar photosphere, the solar chromosphere, and stars of type earlier than A_2. Satisfactory agreement with experimental results [sun, Lyot, *C.R. Acad. Sci., Paris*, **226**, 1251 (1948); stars, Hiltner, *Astrophys. J.*, **106**, 23 (1947)] is obtained. M. W. OVENDEN

523.877

1590. The Balmer discontinuity of HD 190 073. J. BERGER, R. CANAVAGGIA AND D. CHALONGE. *C.R. Acad. Sci., Paris*, **231**, 1124–5 (*Nov.* 20, 1950) *In French.*

Spectra of this peculiar bright-line star have been photographed with a quartz spectrograph attached to the 82 in reflector of the McDonald Observatory, Texas. From a series of comparisons with standard stars in the spectral range 3 300 to 5 000 Å, the obsd. Balmer discontinuity is 0·59, a value not exceeded in any previous measures of abnormal stars made by Barbier and Chalonge. The excess is attributed to absorption in the outer atmosphere of HD 190 073. D. R. BARBER

525.35

1591. On the seasonal variation of the rotation of the earth. A. BILIMOVITCH. *C.R. Acad. Sci., Paris*, **231**, 1034–6 (*Nov.* 13, 1950) *In French.*

Observations with quartz-crystal, and pendulum clocks over a 5 yr period reveal a seasonal influence on the earth's diurnal rotation. During the months June to November the rotational velocity increases; during the remainder, it decreases. These changes can be explained as an effect of solar insolation on meteorological conditions in the N and S hemispheres to lat. 30° S. As a result, large masses of water are transported S to augment the area and mass of the antarctic ice-fields. D. R. BARBER

526.7

1592. The calculation of deflexions of the vertical from gravity anomalies. A. H. COOK. *Proc. Roy. Soc. A*, **204**, 374–95 (*Dec.* 22, 1950).

The theory of the application of gravity measurements to geodetic calculations is discussed, and the errors involved in calculating deflections of the vertical are estimated. If the gravity data are given as free air anomalies from Jeffreys's (1948) formula, so that the 2nd and 3rd harmonics of gravity are assumed known, the orders of magnitude of the standard deviations of the different sources of error are the following: Single deflection: neglect of gravity outside 20°, 1″; difference of deflections: neglect of gravity outside 5°, 0·5″; calculation of effects of gravity from 0·05° to 5°, 0·1″; calculation of effects of gravity within 0·05°, between 0·1″ and 0·5″. Estimates of the deflections are made for Greenwich, Hurstmonceux, Southampton and Bayeux, and the difference between Greenwich and Southampton is compared with the astronomical and geodetic amplitudes. A.

PHYSICS 53

53 : 014.3

1593. Physics abstracting. D. E. GRAY. *Amer. J. Phys.*, **18**, 417–24 (*Oct.*, 1950).

Report of the Study of Physics Abstracting conducted by the American Institute of Physics. The replies of about 1 500 physicists and 200 librarians to questionnaires are analysed and discussed, relating to the effectiveness of existing services in various respects, and the use made of them.

53.08 : 530.162 : 535.14 : 621.391

1594. Communication theory and physics. D. GABOR. *Phil. Mag.*, **41**, 1161–87 (*Nov.*, 1950).

The electromagnetic signals used in communication are subject to the general laws of radiation. A complete representation of a signal is obtained by dividing the time-frequency plane into cells of unit area and associating with every cell a "ladder" of distinguishable steps in signal intensity. The steps are determined by Einstein's law of energy fluctuation, involving both waves and photons. This representation, however, gives only one datum per cell, viz. the energy, while in the classical description there are two data: an amplitude and a phase. It is shown that both descriptions are practically equivalent in the long-wave region, or for strong signals, as they contain approximately the same number of independent, distinguishable data, but the classical

description is always a little less complete than the quantum description. In the best possible experimental analysis by an electronic device the number of distinguishable steps in the measurement of amplitude and phase is only the 4th root of the number of photons. Thus it takes 10^8 photons per cell in order to define amplitude and phase to 1% each. A.

FUNDAMENTALS 530.1

530.11

1595. The irreducible volume character of events. I. A theory of the elementary particles and of fundamental length. B. T. DARLING. *Phys. Rev.*, **80**, 460–6 (*Nov.* 1, 1950).

A theory of elementary particles is presented based on the postulates that the elementary particles are a material process and that with every such process there is associated an inherent irreducible volume of space-time. The equations of motion are obtained from the wave equations of Dirac, Maxwell, etc., through a two-step correspondence principle consisting of replacing these equations by self-adjoint partial difference equations and then integrating these over the group manifold of the closed real orthogonal group G in four-dimensional space. This introduces a new fundamental constant of the dimensions of a length, the difference step ω. The resulting equations are relativistically invariant integro-difference equations in a complex four-dimensional space. They give a quantized mass spectrum when ω is purely imaginary. This paper treats only the Dirac equation. The fundamental integro-difference equation for spin $\frac{1}{2}$ processes is obtained. The mass quantization condition is deduced. In keeping with the basic postulates all elementary charged particles of spin $\frac{1}{2}$ must be embraced by this mass quantization condition which is the case for the electron, proton and μ-meson (predicted mass 218·76 e.m.u.) with the fundamental length $\omega = 4{\cdot}538 \times 10^{-13}$ cm ($\frac{1}{2}$%) larger than the classical electron diameter. This possibility is due to the rather remarkable properties of the mass quantization conditions. There is an infinite number of roots not uniformly spaced and indeed not uniformly non-uniform in this respect: first there is one very small positive root which gives the electron; the next positive root gives on a mass scale the μ-meson at 218 e.m.u.; the distance on the mass scale to the next root suffers a sudden drop to 139 e.m.u., the spacing thereafter dropping uniformly to the asymptotic value of 133·69 e.m.u. The proton is the 13th in the series. Two alternatives for the neutral particles are given, in one of which there is only one elementary neutral particle of spin $\frac{1}{2}$—the neutrino—and the only elementary particles with non-vanishing rest mass are charged, the universality of charge being simply identified with the existence of the particle. Since there is no neutral particle between the neutrino and the μ-meson on either alternative it can be predicted that the μ^0-particle postulated by Tiomno and Wheeler for the decay of the μ-meson must be a neutrino, that is, $\mu \to e + 2\nu$. A.

530.12

1596. The relativistic mass of a rotating cylinder. J. M. GILLOCH AND W. H. MCCREA. *Proc. Camb. Phil. Soc.*, **47** (*Pt* 1) 190–5 (1951).

An investigation by Clark [Abstr. 42 (1950)] is found to provide exceptionally instructive illustrations of the calculation of the variously defined "densities" and "masses" occurring in general relativity theory and of their physical significance. In particular, the effects of motion and stress upon gravitational mass are elucidated. An explicit example shows how kinetic energy is included in the gravitational mass. A.

530.145

1597. The transformation into momentum space in the theory of collisions, G. RIDEAU. *C.R. Acad. Sci., Paris*, **231**, 949–51 (*Nov.* 6, 1950) *In French.*

The transformation is carried through using the integral form of the Schrödinger equation, instead of the usual way. This gives a more convenient answer. G. J. KYNCH

530.145

1598. Early history of quantum mechanics. L. ROSENFELD. *Nature, Lond.*, **166**, 883–4 (*Nov.* 25, 1950).

A succinct outline of the development of quantum-mechanical thought from Bohr's correspondence "argument" to the matrix mechanics of Born, Heisenberg and Jordan and the symbolism of Dirac, and through de Broglie's emphasis of the wave-particle duality to the fruitful wave-mechanics of Schrödinger and its statistical interpretation by Born.

R. H. DALITZ

530.145 : 536.48

1599. Quantum mechanics and low-temperature research. M. H. L. PRYCE AND F. E. SIMON. *Nature, Lond.*, **166**, 887–8 (*Nov.* 25, 1950).

A review pointing out the various ways in which certain distinctive features of quantum mechanics become important at very low temperatures.

D. SHOENBERG

530.145

1600. On the gravitational self-energy of light. S. B. NILSSON AND K. V. LAURIKAINEN. Letter in *Phys. Rev.*, **80**, 291–2 (*Oct.* 15, 1950).

530.145

1601. Mathematical formulation of the quantum theory of electromagnetic interaction. R. P. FEYNMAN. *Phys. Rev.*, **80**, 440–57 (*Nov.* 1, 1950).

The validity of the rules given in previous papers [Abstr. 243, 2187 (1950)] for the solution of problems in quantum electrodynamics is established. Starting with Fermi's formulation of the field as a set of harmonic oscillators, the effect of the oscillators is integrated out in the Lagrangian form of quantum mechanics. There results an expression for the effect of all virtual photons valid to all orders in $e^2/\hbar c$. It is shown that evaluation of this expression as a power series in $e^2/\hbar c$ gives just the terms expected by the aforementioned rules. In addition, a relation is established between the amplitude for a given process in an arbitrary unquantized potential and in a quantum electrodynamical field. This relation permits a simple general statement of the laws of quantum electrodynamics. A description, in Lagrangian quantum-mechanical form, of particles satisfying the

Klein–Gordon equation is given. It involves the use of an extra parameter analogous to proper time to describe the trajectory of the particle in 4 dimensions. The problem of finding what real processes are implied by the formula for virtual processes in the special case of photons is discussed. Problems of the divergences of electrodynamics are not discussed. A.

530.145

1602. Quantum electrodynamics of charged particles without spin. F. ROHRLICH. *Phys. Rev.*, **80**, 666–87 (*Nov.* 15, 1950).

Feynman's formulation of quantum electrodynamics is shown to be equivalent to the Schwinger–Tomonaga theory also for spinless charged particles (mesons) as developed by Kanesawa and Tomonaga. The divergencies of the scattering matrix are analysed to all orders in the fine-structure constant and it is found that mass and charge renormalizations do not remove all divergencies, unlike the electron case. The remaining divergence is associated with the meson-meson interaction and occurs in all orders of radiative corrections except the lowest (second) order in which the process can exist. In order to make the scattering matrix completely finite a direct interaction term $\lambda\phi^*(x)\phi^*(x)\phi(x)\phi(x)$ in the Hamiltonian must be postulated. The infinite coupling constant λ is to be renormalized by an infinite renormalization. One obtains a finite amount of direct interaction which must be determined from experiment. The identical cancellation of certain divergencies to all orders of the fine-structure constant and valid for spin 0, $\frac{1}{2}$ and 1 is proved in the appendix. A.

530.145

1603. Quantum theory of the longitudinal electromagnetic field. S. T. MA. *Phys. Rev.*, **80**, 729–32 (*Nov.* 15, 1950).

The special features of the quantum theory of the longitudinal electromagnetic field originated from the supplementary condition are discussed in connection with the vacuum expectation value of the bilinear form in the electromagnetic potentials. The present investigation confirms the view that the unified treatment of the electromagnetic field is valid for gauge-invariant integrals. A.

530.145

1604. On the quantum theory of the elementary particles. I. Introduction and classical field dynamics. K. V. ROBERTS. *Proc. Roy. Soc. A*, **204**, 123–44 (*Nov.* 22, 1950).

Introduces a classical approach to the interaction representation of Tomonaga and Schwinger, based upon a generalization of analytical dynamics due to Weiss. General rules are deduced for constructing the interaction Hamiltonian function, and it is explained how the consistency of the representation may be established. The classical part of the theory is developed in detail. A.

530.145

1605. On the renormalization of quantum electrodynamics. J. C. WARD. *Proc. Phys. Soc., Lond. A*, **64**, 54–6 (*Jan.*, 1951).

The subtraction procedure of Dyson [Abstr. 4487 (1949)] is modified in order to eliminate a certain difficulty in the renormalization programme, namely the so-called "b" divergencies. The conclusions of Dyson concerning the finiteness of the renormalized *S* matrix are confirmed. A.

530.145 : 538.1

1606. Quantum electrodynamic self-energy and the exact solution of the Schrödinger equation. II. H. SALECKER. *Z. Naturforsch.*, **5a**, 480–92 (*Sept.*, 1950) *In German.*

See Abstr. 837 (1951). The formal solution of the infinite set of simultaneous equations resulting from the Schrödinger equation is given, and the necessary conditions. The failure of the iteration procedure is illustrated by an example where the exact solution is known. A discussion follows on the role of the size of the interaction constant, and renormalization procedures. G. J. KYNCH

530.145 : 538.3 : 535.14

1607. Atomic radiation acting in fissure between reflecting planes. A. LUBNY-GERTSYK. *J. Exp. Theor. Phys.*, **20** (*No.* 2) 127–31 (1950) *In Russian.*

Examines the interaction of the atom with a quantum electromagnetic field bounded by 2 infinite parallel planes reflecting under ideal conditions. Formulae are worked out for the algebraical expression of sparking time and frequency changes. The results of quantum calculation are compared with those obtained from calculation of the radiation of a classical vibrator under similar conditions. Diagrams illustrate (1) the disposition of the reflecting planes and the direction of the axes of the co-ordinates; (2) the dependence of damping "decrement" upon the distance between the reflecting walls; (3) the results of calculations of ϕ coefficients. A simple relation is found to exist between the quantum expression of thermal frequency changes and their classical expression. J. CLEUGH

530.145

1608. On advanced and retarded potentials. A. LANDÉ. Letter in *Phys. Rev.*, **80**, 283 (*Oct.* 15, 1950).

In a discussion of Wheeler and Feynman's theory [Abstr. 3752 (1950)] it is suggested that certain asymmetric initial conditions are physically inconsistent with a symmetric relation assumed by the theory to be valid at all world points. R. A. NEWING

530.145

1609. Non-linear interactions between electromagnetic fields. R. KARPLUS AND M. NEUMAN. *Phys. Rev.*, **80**, 380–5 (*Nov.* 1, 1950).

The covariant *S*-matrix formalism of Dyson has been applied to the calculation of the 4th-order non-linear polarization of the vacuum, which is related to the lowest-order non-linear interaction between electromagnetic fields. The finiteness and the gauge invariance of the interaction are exhibited explicitly by an expression for the 4th-rank vacuum polarization tensor in momentum space. A.

530.145

1610. On the interactions of Birkhoff's gravitational field with the electromagnetic and pair fields. M. MOSHINSKY. *Phys. Rev.*, **80**, 514–19 (*Nov.* 15, 1950).

The flat space-time theory of gravitation proposed by G. D. Birkhoff is discussed from the standpoint of a field theory and, in particular, the interaction of Birkhoff's field with other fields is developed. This interaction is shown to take place through the inter-

action Lagrangian function $h_{\mu\nu}\theta_{\mu\nu}$, and when applied to the electromagnetic and pair fields, it leads to a modification of the Maxwell and Dirac equations. These modified equations determine a change in the index of refraction and a shift of the energy levels of the atom, which account for the bending of light and the red shift in gravitational phenomena. Furthermore, they predict a gravitational correction to the magnetic moment associated with the spin and orbital motion of the electron. A.

530.145

1611. On the negative energy photon hypothesis. T. AWANO. *J. Phys. Soc. Japan*, **5**, 316–21 (*Sept.–Oct.*, 1950).

The notion of an indefinite metric, due to Dirac, is expressed in Schwinger–Tomonaga language, when it is found that the associated "λ-limiting process" has no simple application. J. R. MADDOX

530.145

1612. On the quantum theory of bremsstrahlung. G. PETIAU. *C.R. Acad. Sci., Paris*, **231**, 1038–40 (*Nov.* 13, 1950) *In French.*

A general expression is given for the production of particles of spin 0 or 1, due to coupling with Dirac particles interacting through a static second field of spin 0 or 1. Explicit expressions are given for pseudoscalar fields. G. J. KYNCH

530.145

1613. Spinless mesons in the electromagnetic field. P. T. MATTHEWS. Letter in *Phys. Rev.*, **80**, 292 (*Oct.* 15, 1950).

Rules for the evaluation of the Feynman–Dyson *S*-matrix are stated for spinless mesons interacting with the electromagnetic field. The primitive divergents are enumerated, and, for graphs up to order e^4, it is shown that all divergences may be removed by charge and mass renormalization and by the introduction of a direct meson interaction $\delta\lambda(\phi^*\phi)^2$. R. H. DALITZ

530.145

1614. Spinless mesons and nucleons in the electromagnetic field. P. T. MATTHEWS. Letter in *Phys. Rev.*, **80**, 292–3 (*Oct.* 15, 1950).

The primitive divergents of the Feynman–Dyson *S*-matrix for these 3 interacting fields are the same as for the separate pairs of fields, but have more complex internal structure. For both scalar and pseudoscalar mesons, it is explicitly verified that the conditions necessary for consistency in the interpretation of divergences by the renormalization of mass and charge and by the direct meson interaction $\delta\lambda(\phi^*\phi)^2$ are satisfied up to 4th order in the coupling constants. To this order, the neutron magnetic moment is made finite by these renormalizations [see Abstr. 79 (1951)]. R. H. DALITZ

530.145

1615. On the electromagnetic properties of mesons. E. CORINALDESI. *Nuovo Cim.*, **7**, 892–8 (*Oct.*, 1950).

The influence of the meson-nucleon interaction on the electromagnetic properties of mesons is studied in this paper. The induced meson current is evaluated for scalar and pseudoscalar mesons, and it is proved that it can give an appreciable contribution to the electric scattering. A.

530.145

1616. Variational methods in collision problems. T. KATO. Letter in *Phys. Rev.*, **80**, 475 (*Nov.* 1, 1950).

530.145

1617. On the scattering of π-mesons by nucleons. M. JEAN AND J. PRENTKI. *C.R. Acad. Sci., Paris*, **231**, 1036–8 (*Nov.* 13, 1950) *In French.*

Using symmetric meson theory, cross-sections are given for the following meson-nucleon scattering processes, sc. $\rightarrow$ sc., psc. $\rightarrow$ sc., psc. $\rightarrow$ psc. Angular distributions and total cross-sections are discussed in the ultra-relativistic limit for the various possible meson-nucleon couplings. Non-relativistically, the cross-sections sc. $\rightarrow$ sc. and psc. $\rightarrow$ psc. have a finite limit, whereas the psc. $\rightarrow$ sc. cross-section tends to zero; the observed process $\pi^- + P \rightarrow \pi^0 + N$ thus suggests that π^0, π^- mesons have similar parity. R. H. DALITZ

530.145

1618. Binding energy of the triton. T.-M. HU AND K.-N. HSU. *Proc. Roy. Soc. A*, **204**, 476–88 (*Jan.* 9, 1951).

The variation method is employed to calculate the binding energy of the triton assuming charge-independent, two-body, Yukawa shape interactions between nucleons in which tensor forces are included. More complete trial wave functions are used than employed hitherto in such calculations, and it is found that an interaction of Yukawa shape with constants adjusted to fit the observed data on the binding energy, quadrupole moment and magnetic moment of the deuteron, the low-energy and high-energy scattering of neutrons by protons, the photodisintegration of the deuteron and the coherent scattering of slow neutrons gives an approximately correct binding energy for the triton. Calculations are also carried out with interactions of the same type but with different constants. The exchange character of the forces remains unimportant. It is confirmed that the difference in the binding energies of H^3 and He^3 can be ascribed to the effect of Coulomb repulsion between the protons in the latter nucleus. The wave functions found are used to compute the magnetic moments of the two nuclei but do not contain sufficient admixture of *P* component to explain the observed values. A.

530.145 : 539.18

1619. Static meson potentials and the deuteron problem. P. V. GROSJEAN. Letter in *Nature, Lond.*, **166**, 907–8 (*Nov.* 25, 1950).

Parameters were fixed by the known binding energy, 2·24 MeV, using for meson masses 225 and 284. The quadrupole moment and amount of *D* state were determined. The r^{-3} singularity was removed using the "zero cut-off" of Bethe. The potential-strengths required may not be achieved by any one single type of field. Source parameters are given for solutions obtained using a mixture of pseudoscalar and vector fields. E. P. GEORGE

530.145

1620. Further considerations on Dyson and Feynman's $S(\sigma)$-operator. B. FERRETTI. Letter in *Nuovo Cim.*, **7**, 783–5 (*Sept.*, 1950) *In Italian.*

A preliminary question is investigated from the point of view of a generalization of results obtained

in a previous paper [see Abstr. 3759 (1950)] to the case of discrete eigenvalues of the energy. In this case certain integrals appearing in the theory do not converge. A method is given for the summation of these integrals. L. PINCHERLE

530.145

1621. On the problem of the eigenvalues of the energy for closed systems in field theories. B. FERRETTI. Letter in *Nuovo Cim.*, **7**, 899–900 (*Oct.*, 1950) *In Italian.*

A method is suggested whereby previous considerations [see Abstr. 3759, 7728 (1950), 1620 (1951)] may be extended to the case of discrete eigenvalues of the energy. An equation is given for the operator Π generating a transformation which diagonalizes $H_0 + \lambda H'$ in the representation in which H_0 is diagonal. Π itself is constructed as the limit of a succession. L. PINCHERLE

530.145 : 539.172.13

1622. The theory of the T + D reaction. B. H. FLOWERS. *Proc. Roy. Soc. A*, **204**, 503–13 (*Jan.* 9, 1951).

The energy dependence and absolute magnitude of the cross-section for the T + D reaction are described in terms of the exact wave-functions of the Coulomb field and a complex reaction length defined by the logarithmic derivative of the wave-function on the reaction surface. Previous difficulties in the interpretation of the experiments are largely attributed to the failure of the Wentzel–Kramers–Brillouin approximation. It is sufficient, but not necessary, to assume that the whole cross-section is due to *s*-waves; but in either case the presence of strong spin-orbit coupling is indicated. A.

530.145.6

1623. A variational principle for time-dependent problems. M. CINI AND L. A. RADICATI. Letter in *Phys. Rev.*, **80**, 300–1 (*Oct.* 15, 1950).

530.145.6

1624. On the principle of spectral decomposition in the theory of particles with spin greater than ½. S. SLANSKY. *C.R. Acad. Sci., Paris*, **231**, 892–4 (*Oct.* 30, 1950) *In French.*

This principle applies to the wavefunction of a particle only for operators whose eigenfunctions satisfy certain conditions. These arise from the compatibility of the n wave equations allowed for a particle consisting of n corpuscles each with spin ½. A distinction follows between the density of the mean value of position and the probability density of the presence of the particle. J. JACOBS

530.145.6

1625. Wave equations in momentum space. M. LÉVY. *Proc. Roy. Soc. A*, **204**, 145–69 (*Dec.* 7, 1950).

The non-relativistic and relativistic wave equations of a particle are solved in momentum space for different kinds of fields. It is assumed that the potential, when defined in co-ordinate space, is central; but the method applies also to more general forms of momentum space potentials. First, the general integral equations which correspond, in momentum space, to Schrödinger and Dirac equations are derived, and the angular variables separated. Then, a general method of solution of these integral equations is given, which lies mainly on a transformation into a four-dimensional hyperspace. These results are (relativistically and non-relativistically) applied rigorously to the Coulombian field (H atom) and to the scalar Yukawa potential. A more general case is further investigated. In this, the momentum space potential can be expanded in a series of powers of the modulus of the momentum (this last application involves a cut-off procedure). A mathematical appendix deals with some properties of the hyperspherical harmonics (especially the integral equation of these functions) and with the Fourier transform of some kinds of central potentials. A.

530.15

1626. Cohesion, nuclear forces and Newton's law. Q. MAJORANA. *Atti Accad. Naz. Lincei* (*R.C. Cl. Sci. Fis. Mat. Nat.*) **9**, 3–8 (*July–Aug.*, 1950) *In Italian.*

A qualitative discussion of the possibility of a unified theory of attractive forces in terms of classical concepts such as the emission and absorption of a gravitational fluid. R. A. NEWING

530.162

1627. Fermi–Dirac functions of integral order. P. RHODES. *Proc. Roy. Soc. A*, **204**, 396–405 (*Dec.* 22, 1950).

After a brief indication of the types of physical problem in which they arise, an account is given of methods of evaluation of the Fermi–Dirac functions, $F_n(\eta) = \int_0^\infty \{x^n/(\theta^{x-\eta} + 1)\}dx$, for positive integral values of n. A.

530.162

1628. The "velocity" of Brownian movement. R. FÜRTH. *Phil. Mag.*, **41**, 1255–8 (*Dec.*, 1950).

The notion of the velocity of the random movement of a particle and the problem of its observation is discussed in view of certain incorrect statements in a recent paper by D. K. C. MacDonald [Abstr. 7753 (1950)]. A.

530.162 : 536.71

1629. The quantum-mechanical equation of state. R. W. ZWANZIG. Letter in *J. Chem. Phys.*, **18**, 1412–13 (*Oct.*, 1950).

To find the equation it is necessary to find the dependence of energy levels on volume. The required function is obtained by introducing the volume as a scale factor into the Schrödinger equation of a bounded isolated system. The result obtained agrees with that of de Boer [Abstr. 1551–2 (1950)]. G. J. KYNCH

GENERAL MECHANICS . MECHANICS OF SOLIDS 531

531.252.2

1630. The rigidity of corrugated diaphragms. J. A. HARINGX. *Appl. Sci. Res.*, **A2** (*No.* 4) 299–325 (1950).

When the corrugated diaphragm is replaced by a fictitious flat plate of similar properties it is possible to derive a linear differential equation for the deflec-

tion. The coefficients of this equation, however, vary in a complicated way and its solution for the pressure-loaded diaphragm is only given for thick and for thin sheets separately. The results for thick and for thin sheets are fitted together, so that the deflection can also be determined for the intermediate range of thickness. It is to be remarked that, compared on the basis of small deflections, the introduction of corrugations into the sheet leads to a considerable increase of rigidity of the diaphragm. The prevailing assertion that the flat plate is more rigid than the corrugated diaphragm holds only for large deflections, because of the non-linearity between the load and the deflection of the flat plate. A.

531.44

1631. Basic physical processes in brake contact. L. V. YANKOVSKAYA. *J. Tech. Phys., USSR*, **20**, 412–19 (*April*, 1950) *In Russian.*

The physical nature of the sliding contact between a flexible elastic band and a rotating cylinder is investigated, the main characteristic of which is a non-uniform distribution of the normal pressure along the subtended arc. The treatment is based on the equation of motion of the band and on the assumption of the validity of Hooke's law for the material of the band. This treatment is quite different from the usual technical one, and results in a relation determining the linear wear, viz. $\Delta z_1 = \Delta m_1/S_1\rho$, where ρ is the density of the band, S_1 its cross-sectional area; in the last event it determines the time after which the cross-section of the band will have become dangerously small. B. F. KRAUS

MECHANICAL MEASUREMENTS 531.7

531.715.1 : 535.417

Interferometric measurement of thickness of evaporated films. *See Abstr.* 1767

531.715.2

1632. The measurement with the microscope of inaccessible dimensions of macroscopic bodies. G. SCHENDELL. *Arch. tech. Messen, Issue No.* 178 (*Ref. V*1121–8) *T*120 (*Nov.*, 1950) *In German.*

Two arrangements are described. They are suitable for measurements of, for example, electrode dimensions or spacings which are inaccessible due to enclosure in glass envelopes or are at high potentials. S. WEINTROUB

531.719.24 : 519.27

1633. Distribution of range-finding errors. J. H. CADWELL AND K. H. SPRING. Letter in *Nature, Lond.*, **166**, 906–7 (*Nov.* 25, 1950).

The frequency distribution of errors expressed as y = range error/(true range)^2 is found from trials to depart from the normal form and to show significant skewness. This skewness is shown to arise from the approximation used, which implies that equal range errors will arise from equal angular errors of opposite sign. After making allowance for this, the distribution is found to be symmetrical although still not normal. R. W. FISH

531.754.2

1634. Measurement and control of bulk density. W. T. RAWLES. *Gen. Elect. Rev.*, **53**, 48–9 (*Nov.*, 1950).

In using powders in metallurgy and elsewhere, it is frequently necessary that the bulk density be constant and known. The bulk density depends not only on the particle size distribution, but also upon the method and degree of vibration employed to compact it, and the method of measuring bulk density should be related to the filling machine to use the powder. Density characterization curves have been produced for powders by vibrating them by 4 methods (the variables used being amplitude, frequency and duration). The bulk density attained is plotted against the method employed, and it is stated that one powder will have the same compacting properties as another when their curves are identical. Once a powder has been found satisfactory in a filling machine, all powders having like characteristic curves will also be satisfactory. A. C. WHIFFIN

531.78

1635. An instrument for the calibration of dynamometers. A. MICHELS AND J. P. WASSENAAR. *Appl. Sci. Res.*, **A2** (*No.* 4) 245–8 (1950).

An instrument is described for the calibration of dynamometers with which forces can be measured between 100 and 30 000 kg with a reproducibility varying from 0·5 to 3 kg over this range. This accuracy is obtained by applying the principle of the rotating piston as developed for pressure balances. A.

531.787.9 : 621.317.39

1636. A new method of measuring pressure electrically. E. C. BLOM. *Instruments*, **23**, 903 (*Sept.*, 1950).

A sealed chamber containing gas at a known pressure is heated by an external coil until the gas pressure exceeds the sample pressure on the opposite side of a diaphragm forming one wall of the chamber, causing contacts to separate and turn off the heater via a thyratron circuit. As cooling occurs the contacts reclose, the chamber reheats and so on until finally the temperature of the chamber stabilizes at a value proportional to the pressure being measured. A thermistor bridge measures the chamber temperature and its circuit may be directly calibrated in pressure. The device is robust, suitable for industrial locations, insensitive to ambient temperature changes, and covers approximately 700–790 mm Hg with 1 mm accuracy. E. D. HART

MECHANICS OF FLUIDS 532

532.13 : 537.212

1637. The effect of an electric field on the viscosity of liquids. II. E. N. DA C. ANDRADE AND C. DODD. *Proc. Roy. Soc. A*, **204**, 449–64 (*Jan.* 9, 1951).

See Abstr. 763 (1947) for Part I. To obtain the true effect measurements must be made with alternating fields whose frequency lies within a certain range. As the effect is very small, a very sensitive method of measurements of viscosity must be devised

and various temperature effects must be eliminated. Apparatus and methods are described which allow comparative viscosities to be consistently measured, with and without field, to within a few parts in a million. With this disposition it has been shown that for non-polar benzene there is no effect as large as 1 part in 100 000, even with the highest applied fields. With polar liquids, however, there is a true, but small, increase of viscosity proportional to the square of the field. A brief theoretical discussion is given, in which it is shown that electrostriction cannot be responsible for the effect. A.

532.133

1638. Viscosity data of organic liquids. J. W. M. BOELHOUWER, G. W. NEDERBRAGT AND G. VERBERG. *Appl. Sci. Res.*, **A2** (*No.* 4) 249–68 (1950).

Viscosities have been measured of thirty-seven organic liquids, with molecular weights ranging from 120 to 807, and the viscosity-temperature curves obtained are compared with those of *n*-paraffins. The influence of ring structures and polar groups on viscosity is discussed. A.

532.133

1639. The measurement of viscosity. I. Fundamentals. H. UMSTÄTTER. *Arch. tech. Messen*, *Issue No.* 178 (*Ref. V*9122–6), *T*129–30 (*Nov.*, 1950) *In German.*

A review of the ways in which a measured viscosity coefficient can depend on the previous history of the material, on rate of shear, temperature, pressure and on concentration in the case of colloidal or macromolecular substances. References. J. G. OLDROYD

532.133

1640. Viscosity of liquids at high rates of shear. A. F. H. WARD, S. M. NEALE AND N. F. BILTON. Letter in *Nature, Lond.*, **166,** 905 (*Nov.* 25, 1950).

Measurements of viscosity of a mineral oil at high rates of shear have shown that the anomalous fall in viscosity increases with the rate of shear but falls rapidly with rising temperature, as was predicted by the theory of Grunberg and Nissan [Abstr. 2774 (1945)]. T. C. TOYE

532.133

1641. Viscosity—temperature dependence. A. V. BRANCKER. Letter in *Nature, Lond.*, **166,** 905–6 (*Nov.* 25, 1950).

It is suggested that the equations normally used to represent viscosity-temperature data are unsatisfactory, consideration of published values for a number of liquids having indicated that a simple equation of the form $\eta(1 - a/T) = b$, where a and b are constants, would hold at all temperatures except those near the boiling points. T. C. TOYE

532.51

1642. On the stability of a fluid heated from below. O. G. SUTTON. *Proc. Roy. Soc. A,* **204,** 297–309 (*Dec.* 22, 1950).

The problem has been re-examined, on the assumption that the new mode found by Chandra and Dassanayake arises from instability in a shallow boundary layer, whose depth is unrelated to the distance between the upper and lower rigid boundaries. It is shown that the criterion for the "columnar" mode involves only the ratio of the absolute temperatures of the upper and lower surfaces, and an expression is derived and verified for the critical temperature difference at which the transition takes place from the "columnar" to the "cellular" mode. Finally, it is shown that the Rayleigh mode will occur if the depth of the fluid exceeds a certain value, but that for the more shallow layers, the "columnar" mode will be generated initially, ultimately passing to the "cellular" mode for increased temperature difference. A.

532.517.3

1643. Transition between laminar and turbulent flow in various liquids. G. RAUMANN, I. S. NIXON AND K. G. DENBIGH. *Research, Lond.*, 3, 520–5 (*Nov.*, 1950).

Experimental studies have been carried out on the transition between laminar and turbulent flow in the following liquids: water, acetone, butanol, ether and solutions of benzopurpurin and polymethyl methacrylate. Most of the work was carried out at 20°C, but experiments on ether were conducted also at 0°C and − 80°C. The results confirm the correctness of the Reynolds number in determining the stable type of flow, and it seems therefore that the viscosity and the density are the only properties of the fluid which are of significance with regard to the mechanism of the fully developed turbulent motion. On the other hand, it has been noted that there are certain specific differences of behaviour between the various liquids regarding the ease of transition between laminar and turbulent flow. The presence of colloidal particles, in particular, seems to facilitate the transition. It is also shown that the pressure drop in a straight tube continues to be proportional to the fluid velocity in the quasi-turbulent region between Reynolds numbers of 2 200 and 3 000. Above $R_e = 5\,000$ the present results are in agreement with the equation of Blasius. A.

532.517.4

1644. A comparison of Heisenberg's spectrum of turbulence with experiment. I. PROUDMAN. *Proc. Camb. Phil. Soc.*, **47** (*Pt* 1) 158–76 (1951).

In this paper, the theoretical double and triple velocity correlation functions which correspond to Heisenberg's spectrum of isotropic turbulence, are obtained numerically for two Reynolds numbers, infinite and finite. These theoretical correlations are then compared with the results of experiment. When κ, which is a numerical constant occurring in Heisenberg's equation for the spectrum, is given a value 0·45, the general shape and scale of the theoretical correlations are in fairly good agreement with experiment. There is no significant variation of κ with Reynolds number over the range of the latter which is considered (i.e. $R_\lambda > 27$). An important theoretical prediction, which appears to be in agreement with experiment, is that, as the Reynolds number is increased, the spectrum attains the asymptotic shape appropriate to infinite Reynolds number more rapidly for small wave numbers than for large. A fundamental postulate of the theory is that the spectrum as a whole completely preserves its shape during the decay process. This is not true over an appreciable range of large energy-containing eddies. The

detailed distribution of energy in the small eddies, however, appears to be unsatisfactory. Another author has obtained, for large Reynolds numbers, the value of $\kappa = 0{\cdot}13$ for small eddies. A similar determination is here made for small Reynolds numbers, and the result is a value which is orders of magnitude smaller than the previous two values. Thus, at large wave numbers, neither the distribution of energy in the spectrum, nor the variation of the spectrum with Reynolds number, is satisfactory. A.

532.517.4 : 533.6.01

Triple velocity correlations in isotropic turbulence. *See Abstr.* 1657

532.574.6 : 534.321.9

1645. Measuring water velocity by an ultrasonic method. W. B. Hess, R. C. Swingal and S. K. Waldorf. *Elect. Engng, N.Y.*, **69**, 983 (*Nov.*, 1950). [Digest of *Amer. Inst. Elect. Engrs, Paper* **50–114.**]

Two transducer rods, which convert h.f. currents to sound waves or vice versa, are placed in the duct carrying the water. The phase angle between the transmitted and received signal is a measure of the water velocity. Laboratory tests show an average error of about 1%. It is proposed to apply the method to water measurements in low-head hydro-electric stations. E. O. TAYLOR

532.59 : 538.69

1646. The invariant theory of isotropic turbulence in magneto-hydrodynamics. S. Chandrasekhar. *Proc. Roy. Soc. A*, **204**, 435–49 (*Jan.* 9, 1951).

The theory is developed on the basis of the equations of motion recently derived by Batchelor to describe the hydrodynamics of an incompressible fluid which is also a good electrical conductor. The theory allows for the interaction between the electromagnetic field and the turbulent motion when there is no externally imposed electric or magnetic field. Various double and triple correlation tensors involving the components of the velocity and the magnetic field intensity are defined, and three equations governing the scalars defining these tensors are derived; these latter equations admit integrals of Loitsiansky's type. The equations governing the dissipation of energy by viscosity and conductivity are also derived; they exhibit the manner in which energy is exchanged between the velocity and the magnetic fields. Finally, the equations appropriate for the case, when an external agency supplies kinetic energy to the system at a constant rate and a stationary condition prevails, are obtained; they suggest that the energy in the magnetic field is contained, principally, in the eddies with large wave numbers. A.

532.593

1647. The wave motion of the sea at a beach. M. Roseau. *C.R. Acad. Sci., Paris*, **231**, 1212–14 (*Nov.* 27, 1950) *In French.*

Solutions for the irrotational wave motion of the sea at a shelving beach, given by $y + x \tan \alpha = 0$, are derived for two cases: (1) when the potential, Φ, is expressed in the form $\Phi = \exp i\sigma t \,.\, \phi(x, y)$, and (2) when $\Phi = \exp(i\kappa z + \sigma t) \,.\, \phi(x, y)$, where z is the elevation of the free surface. In each case the potential in the body of the fluid is expressed in terms of Green's functions. J. S. G. THOMAS

532.613 : 541.18.04

The rate of surface tension lowering and its role in foaming. *See Abstr.* 2138

MOLECULAR THEORY OF LIQUIDS 532.7

532.7 : 536.4

1648. Discontinuities in the properties of matter as a function of the temperature. G. Antonoff, A. Urmanczy and A. Yakimac. *C.R. Acad. Sci., Paris*, **231**, 952–3 (*Nov.* 6, 1950) *In French.*

Many physical properties of liquids exhibit discontinuous changes with temperature as shown previously by Antonoff. Formulae containing constants which take different values between the discontinuities are given for vapour pressure and viscosity; these are claimed to give a perfect representation of the experimental results. Six discontinuities are found in the vapour pressure of water between $-40{\cdot}25$°C and $290{\cdot}64$°C. A number of substances besides water have been studied with similar results. The phenomena may be interpreted by a theory of molecular aggregation. F. E. HOARE

532.72

1649. Some consequences of Bernoulli's equation. V. I. Sokolov. *J. Tech. Phys., USSR*, **20**, 472–5 (*April*, 1950) *In Russian.*

The Bernoulli–Euler equation (or "integral") is set up for a liquid in a purely centrifugal field (i.e. when gravity effects become negligible) and the results applied to the representation of the flow in an ultra-centrifuge. B. F. KRAUS

532.72

1650. On the concentration dependence of the rates of diffusion of macromolecules in solution. An investigation of fractions of polystyrene. A. F. Schick and S. J. Singer. *J. Phys. Coll. Chem.*, **54**, 1028–44 (*Oct.*, 1950).

The formulation of the concentration dependence of the diffusion constant in terms of two independently measurable quantities, the increase in osmotic pressure and in the frictional coefficient with concentration, has been verified. This indicates that the basic assumptions involved in this formulation are satisfied: namely, that the gradient of the free energy of dilution is the driving force of the diffusion process, and that the frictional coefficients in sedimentation and diffusion are the same. Both positive and negative values have been found for polystyrene solutions. This has been shown to be possible, depending on the relative contributions of the hydrodynamic and thermodynamic factors to the diffusion rate. Variation with respect to molecular weight and solvent power has also been discussed. A.

532.72 : 535.417

1651. Interferometric studies in diffusion. I. Determination of concentration distributions. C. Robinson. *Proc. Roy. Soc. A*, **204**, 339–59 (*Dec.* 22, 1950).

An interferometer technique for the quantitative study of swelling and diffusion in transparent high polymers and a method of determining the con-

centration distribution from the fringe system have been developed. The concentration/distance curves in the system chloroform-stretched cellulose acetate have been determined at two different temperatures with a view to estimating activation energies over a range of concentrations. The curves are found to consist of two almost linear portions with a considerable and abrupt change of gradient taking place over a small range of concentration. A corresponding sudden change of gradient has been observed in other systems. Considerable experimental difficulties were met in determining the refractive index and density curves for the two component systems, which were required by the method. Eventually a refractive index curve was constructed with the help of data obtained by several approaches. A.

532.72 : 535.417

1652. Interferometric studies in diffusion. II. Influence of concentration and orientation on diffusion in cellulose acetate. J. CRANK AND C. ROBINSON. *Proc. Roy. Soc. A*, **204,** 549–69 (*Jan.* 9, 1951).

The techniques developed in part I [Abstr. 1651 (1951)] are used to study the diffusion of the five penetrants, chloroform, acetone, methylene chloride, water and methyl alcohol in stretched cellulose acetate sheet. In each case a marked increase in diffusion coefficient occurs at a volume concentration of penetrant of about 60 to 70%. The results for chloroform indicate a mean activation energy of about 6 kcal. Photographs of interferometer fringe systems in the neighbourhood of a corner of the cellulose acetate sheet are shown for each penetrant. Each photograph reveals anisotropic behaviour. This behaviour is due partly to the diffusion coefficient being less in the direction of stretch, than perpendicular to it, and partly to the overall range of concentration being less as a result of the restricted swelling of the polymer in the former direction. New evidence is provided on the nature of the sharp boundaries seen under the microscope when a penetrant enters a polymer. In particular the middle boundary, which approximately indicates the concentration at which the polymer relaxes and becomes isotropic, is found to occur at a volume concentration of 60 to 70% for each penetrant examined quantitatively. A.

MECHANICS OF GASES 533

533.15

1653. Measurement of thermal diffusion ratio by "bending balance." K. MATSUDA AND N. ONO. *J. Phys. Soc. Japan*, **5,** 238–40 (*July–Aug.*, 1950).

For N_2–H_2 mixtures in a "two-bulb" apparatus.

R. H. DAVIES

533.15 : 536.48

1654. Measurements on the thermal diffusion of Ne_2–H_2, Ne–D_2 and Ne–He mixtures at liquid hydrogen temperatures. A. DE TROYER, A. VAN ITTERBEEK AND G. J. VAN DEN BERG. *Physica*, **16,** 669–77 (*Sept.*, 1950).

In order to get more information concerning the attractive forces of the molecules [see *ibid.*, **13,** 231–9 (1947); Abstr. 5588 (1950)] thermal diffusion experiments on the mixtures Ne–H_2, Ne–D_2 and Ne–He have been done. The degree of separation was determined by means of viscosity measurements. The results show a similar behaviour concerning the attractive forces for the mixtures Ne–H_2 and Ne–D_2. The curve of the degree of separation as a function of the logarithm of the ratio of the temperatures used shows for the mixture Ne–He a smaller influence of the attractive forces than for the mixtures mentioned above. A.

533.16

1655. The viscosity of sulfur vapor. G. A. DALIN AND J. R. WEST. *J. Phys. Coll. Chem.*, **54,** 1215–21 (*Nov.*, 1950).

By means of the capillary method the viscosity of sulphur vapour was measured at its boiling point. The experimental value was found to agree with the calculations by two empirical methods. Computed results are presented for other temperatures. A.

533.27

1656. Dissolution of phenanthrene in compressed gases. S. ROBIN AND B. VODAR. Letter in *J. Chem. Phys.*, **18,** 1413–14 (*Oct.*, 1950).

533.6.01 : 532.517.4

1657. Triple velocity correlations in isotropic turbulence. R. W. STEWART. *Proc. Camb. Phil. Soc.*, **47** (*Pt* 1) 146–57 (1951).

533.6.011.3

1658. Simple calculation of the coefficients of the characteristic function of a reaction turbine in the sonic region. J. VALENSI. *C.R. Acad. Sci., Paris*, **231,** 1032–4 (*Nov.* 13, 1950) *In French.*

When sonic flow occurs at the nozzle outlet, it is shown, by making certain approximations, that the absolute temperature at the entry to the turbine distributor is proportional to the square of the speed of rotation. From this result expressions are easily deduced for the coefficients of the characteristic function of the reaction turbine. E. H. DOCK

533.6.011.311 : 551.573

1659. A note on Rayleigh's problem for a plate of finite width. D. R. DAVIES. *Proc. Camb. Phil. Soc.*, **47** (*Pt* 1) 248–50 (1951).

This note indicates the relation between (*a*) the problem of evaporation from a finite area of rectangular shape into a turbulent air stream and of the boundary layer on a flat plate of finite width, and (*b*) the problem of the boundary layer on a semi-infinite plate and evaporation from an infinite quadrant. A.

533.6.08

1660. New methods of measurement with a hot-wire anemometer. G. DÄTWYLER. *C.R. Acad. Sci., Paris*, **231,** 945–7 (*Nov.* 6, 1950) *In French.*

A heated wire is mounted in a Wheatstone bridge, which is then balanced in the usual way, except that a galvanometer giving a deflection proportional to the square of the current is used. The wire is then placed in turbulent air, and the rate of loss of heat will be subject to fluctuations which will unbalance the bridge. Even if the mean temperature is unaltered, there will be a reading of the galvanometer. By

superposing an alternating current on the whole bridge, and adjusting its value so that the galvanometer reading is doubled, the current can be used as a measure of the turbulence, on the assumption that there is no correlation between the regular fluctuations of the a.c. and the random fluctuations of the turbulence. N. CORCORAN

533.6.08 : 551.508.5

1661. A note on the calibration and use of a shielded hot-wire anemometer for very low speeds. C. F. COWDREY. *J. Sci. Instrum.*, **27**, 327–9 (*Dec.*, 1950).

A method is described for calibrating low-speed hot-wire anemometers by the use of a small whirling arm. Results are also included showing the errors introduced when the anemometer is inclined to the wind direction. A.

MOLECULAR THEORY OF GASES 533.7

533.7

1662. On the transport of aluminum atoms by a gas. M. TER-POGOSSIAN, F. T. PORTER AND C. S. COOK. Letter in *Phys. Rev.*, **80**, 294–5 (*Oct.* 15, 1950).

533.7 : 530.162 : 536.48

1663. Transport phenomena in degenerate systems. I. General theory in a mixed system. A. ISIHARA. *J. Phys. Soc. Japan*, **5**, 213–17 (*July–Aug.*, 1950).

The treatment of transport phenomena in gases developed by Enskog, Chapman and others [see Chapman and Cowling, *Mathematical theory of non-uniform gases*, Cambridge (1939)] is altered for the case of degenerate gases at very low temperatures. A mixed system of gases obeying different statistics is considered. T. C. TOYE

533.7 : 530.162 : 536.48

1664. Transport phenomena in degenerate systems. II. Degenerate Bose–Einstein gas. A. ISIHARA. *J. Phys. Soc. Japan*, **5**, 217–22 (*July–Aug.*, 1950).

An extension of the work of I (preceding Abstr.), the effect of condensation on the gas coefficients for a Bose–Einstein gas being examined. See also Uehling and Uhlenbeck, *Phys. Rev.*, **43**, 552 (1933).

T. C. TOYE

533.75

1665. A study of the two-component van der Waals fluids. J. W. DRENAN AND T. L. HILL. *J. Phys. Coll. Chem.*, **54**, 1132–47 (*Nov.*, 1950).

The partition function for a two-component fluid, each component of which when pure satisfies the statistical model leading to van der Waals' equation of state, has been derived. From this are obtained the equation of state for this system in 3 dimensions, the critical constants of the system, and the vapour pressures of the components; the dependence of these properties on the values of the mole fraction and of the van der Waals a and b is discussed. The model is shown to break down when the molecular volumes of the two components are too dissimilar. This emphasizes the faulty nature of the original van der Waals picture. An alternative method of obtaining liquid-vapour composition diagrams, based upon the equivalence of the chemical potential in each phase, is discussed. The behaviour of the system upon condensation is also considered. The partition function, equation of state and vapour pressure curves of a two-component, two-dimensional van der Waals' adsorbate are discussed. Various types of isotherms based upon this model are then examined. A.

533.75 : 541.123.2

1666. Critical behavior and liquid-vapor equilibrium in mixtures of fluids. C. A. BOYD. *J. Phys. Coll. Chem.*, **54**, 1347–57 (*Dec.*, 1950).

A general discussion is given of the liquid-vapour equilibrium in a binary system, with particular attention to the phenomenon of retrograde condensation. By way of illustration, the behaviour of the ethane-heptane system is elucidated by a series of phase diagrams. The thermodynamics of the liquid-vapour equilibrium is developed, and the van der Waals' equation of state is introduced. In this way the difference in the treatment required for pure systems and for binary systems has been shown, and the ground laid for future calculations of a semi-quantitative nature. A.

VIBRATIONS . ACOUSTICS 534

534.2 : 535.12 : 538.566

1667. Waves in anisotropic conditions of propagation. H. POEVERLEIN. *Z. Naturforsch.*, **5a**, 492–9 (*Sept.*, 1950) *In German.*

A theoretical discussion of the index surface of Hamilton and MacCullagh (1837) and the principle that the ray direction is normal to this surface. The ideas are applicable not only in crystal optics but in general to waves in anisotropic media, e.g. radio waves in the ionosphere. Examples treated here are sound waves in air and the motion of electrons in a magnetic field. M. R. HOPKINS

534.21 : 533.6.011.5

1668. On the propagation of disturbances from moving sources. A. G. WALTERS. *Proc. Camb. Phil. Soc.*, **47** (*Pt* 1) 109–26 (1951).

The concept of the Green's vibrational function given earlier [Walters, *ibid.*, **45**, 69–80 (1949)] is used to obtain a general expression for the disturbance from a point source. The potential due to transient sources of sound moving with subsonic and supersonic velocities is derived from this. It is found that the Doppler effect for a supersonic source differs from that for a subsonic source. In the former case it is found that two frequencies are heard simultaneously from a source emitting a note of one frequency. The theory is applied to determine some solutions of the two-dimensional equation of supersonic, irrotational compressible flow, corresponding to the flow around an aerofoil taking into consideration the entropy changes at the shock wave. A.

534.21 : 536.48

Theory of the propagation of sound in He II. *See Abstr.* 1807

534.213 : 548.0

1669. The theory of the propagation of ultrasonic waves in polycrystals. I. M. LIFSHITS AND G. D. PARKHOMOVSKIĬ. *J. Exp. Theor. Phys., USSR*, **20**, 175–82 (*Feb.*, 1950) *In Russian.*

The propagation of ultrasonic waves in a polycrystalline medium and in particular the absorption caused by scattering at irregularities is examined theoretically. At high frequencies the latter may account for a greater part of the total absorption than heat conductivity and viscosity. The equation of motion of an anisotropic elastic medium is set up using microscopic moduli of elasticity and is averaged according to the probable orientation distribution of the crystallites. An equation of motion in terms of macroscopic moduli results. In the formalism of the theory the dynamic macroscopic moduli are shown to be complex, the coefficient of absorption being determined by the imaginary parts of the moduli and the dispersion by the real parts. In the limiting case when λ is large the coefficient of absorption γ is found to be $\propto f^4a^3$ (f is the frequency and a the mean size of the crystallites) and when λ is small $\gamma \propto f^2a$. For crystallites of the cubic system the expressions for γ are further simplified. A. L. MACKAY

534.213.4

1670. Boundary layer attenuation of higher order modes in rectangular and circular tubes. R. E. BEATTY, JR. *J. Acoust. Soc. Amer.*, **22**, 850–4 (*Nov.*, 1950).

The boundary layer attenuation caused by viscous and thermal losses of all higher order modes of propagation in rigid walled rectangular and circular tubes has been calculated using the concept of boundary layer admittance introduced by Cremer. In the case of the rectangular tube Cremer's admittance formula for obliquely incident waves is applied directly in conjunction with Morse's duct formulae to obtain the attenuation of $(n_y, 0)$ and (n_y, n_z) modes. The boundary layer admittance of higher order modes in circular tubes is obtained from an extension of Cremer's method for plane waves. An electromagnetic waveguide technique for calculating "skin" losses is applied to determine the attenuation of the asymmetric (m, n) circular tube modes. It is shown that the symmetric $(0, n)$ circular tube modes are the least attenuated of all higher order modes in both rectangular and circular tubes; above a certain frequency the attenuation is less than the plane wave attenuation. A.

534.221

1671. Dispersion of ultrasonic velocity in the liquid fatty acids. Y. WADA, S. SHIMBO AND M. ODA. *J. Phys. Soc. Japan*, **5**, 345–8 (*Sept.–Oct.*, 1950).

Measurements have been made on stearic, palmitic and lauric acids in a freq. range of 0·61–6·28 Mc/s, at temperatures from 95°C to solidifying points, using an ultrasonic interferometer. No dispersion was observed in the higher temperature-range, but near the solidifying point the sound velocity had a max. value at a characteristic frequency which was lower the higher the acid. The dispersion is explained in terms of a resonant rather than relaxation phenomenon and the possibility of its use in qualitative analysis of fatty acids is mentioned. G. F. HODSMAN

534.221

1672. Ultrasonic dispersion in organic vapours. J. D. LAMBERT AND J. S. ROWLINSON. *Proc. Roy. Soc. A*, **204**, 424–34 (*Dec.* 22, 1950).

The velocity of ultrasonic waves has been measured in a series of organic vapours at frequencies 566, 1 192 and 4 000 kc/s, temperatures 20 and 100°C, and pressures ranging from 0·25 to 4 atm. Ultrasonic dispersion was found with benzene, cyclopropane and ethane. No dispersion was found with propane, *n*-hexane, cyclohexane, cyclohexene, ethyl chloride, chloroform, acetonitrile, acetaldehyde, acetone, diethyl ether and methyl alcohol. The mechanism and rate of the activation of vibrational energy by intermolecular collisions are discussed in relation to molecular structure. It is concluded that, for polyatomic molecules in general, there is little hindrance to the interconversion of translational and vibrational energy, especially at high temperatures. Slow interconversion, leading to ultrasonic dispersion, only occurs with small or rigid molecules, where internal rotations or vibrations of low frequency are absent. Interchange of vibrational energy between the different modes within the molecule is usually very rapid. A.

534.222.2

1673. The energy distribution behind decaying shocks. I. Plane waves. M. J. LIGHTHILL. *Phil. Mag.*, **41**, 1101–28 (*Nov.*, 1950).

A critical examination of an approximate theory by K. O. Friedrichs [*Commun. Appl. Maths.*, **1**, 211–45 (1948)]. This theory deals with the motion of a perfect gas behind the shockwave generated by a piston set impulsively in motion and then brought gradually to rest; it is assumed that motion is restricted to the region between the shockwave and a following sound wave (sent out by the piston as it comes to rest), and that the specific entropy of the moving gas is the same as in the undisturbed state. This approx. solution may be termed the "simple wave." In the present paper, Friedrichs's theory is extended to cover a fluid having arbitrary thermodynamic properties, and the total energy of the gas in the "simple wave" is compared with the work done by the piston; these differ by an amount comparable with the entropy gain of the fluid as it passes through the shockwave, the difference being attributed to the motion of the gas behind the "simple wave." A closer examination of the gas-flow in this region shows that the pressure distribution is that which would be produced by reflection of the "simple wave" at the shock front, giving rise to a pressure pulse whose reflection at the piston would cause motion of the gas in the region behind the "simple wave." It is concluded that the errors in Friedrichs's theory are comparable with the changes produced by altering the "simple wave" in two respects: (*a*) the specific entropy of the whole wave is altered to its known maximum as a result of passage through the shock front; (*b*) the velocity distribution is altered (e.g. by altering the piston velocity by an amount whose ratio to the local velocity of sound is of the order of the cube of the shock strength). The Friedrichs theory is further extended to include the case when the piston, set impulsively in motion, is decelerated through zero to a negative

velocity, and then brought abruptly to rest, to produce a second shockwave following that set up by the initial motion. It is shown that the accuracy of Friedrichs's theory is maintained so far as the first shock is concerned, but the motion of the second shock at a large distance from the piston is given less accurately. A. SCHOFIELD

534.23

1674. Measurements of the absorption of sound in water at 358, 540, 1 074 and 1 790 kc/s. A. VAN ITTERBEEK AND A. DE BOCK. *Proc. Univ. Durham Phil. Soc.*, *Pt* 7, 547–55 (1950).

Measurements of the absorption coefficient α by the radiation pressure method confirm the results of Sörensen [*Ann. Phys.*, **26**, 121–37 (*May*, 1936)] and Hartmann and Focke [Abstr. 1238 (1940)] that there is a pronounced increase in the value of α/ν^2 as the frequency ν is decreased below 1 Mc/s. G. L. WILSON

534.23

1675. Absorption of ultrasonics in liquids from thermal considerations. S. PARTHASARATHY, D. SRINIVASAN AND S. S. CHARI. Letter in *Nature, Lond.*, **166**, 828–9 (*Nov.* 11, 1950).

534.23

1676. Effects of humidity on ultrasonic absorption in air at 1·46 megacycles. G. S. VERMA. *J. Acoust. Soc. Amer.*, **22**, 861–2 (*Nov.*, 1950).

The absorption coefficient for moist air has been measured at 1·46 Mc/s for relative humidities varying from zero to 84%. Maximum absorption at this frequency ($\alpha = 0{\cdot}52\ \mathrm{cm}^{-1}$) is found to occur at 46% relative humidity. A.

534.231.3

1677. The velocity of sound through tissues and the acoustic impedance of tissues. G. D. LUDWIG. *J. Acoust. Soc. Amer.*, **22**, 862–6 (*Nov.*, 1950).

The velocity of sound through various animal organ tissues and through living human tissues is measured, using an ultrasonic pulse method, at 1·25 and 2·5 Mc/s. The effect of anisotropy (fibre direction) on velocity is determined with beef muscle. Values obtained with the beam traversing the tissue perpendicularly to the long axis of the muscle bundles do not differ significantly from those found with the energy directed parallel with the muscle fibres. Velocity through living human tissues, consisting mostly of muscle, is measured by transmitting the ultrasound through various thicknesses of the arm, leg and thigh. Specific gravities of the tissues are measured. The characteristic acoustic impedances (ρc values), calculated from the density and velocity data, vary between $1{\cdot}5\times10^5$ and $1{\cdot}7\times10^5$ g/cm²/sec. The imaginary component of tissue impedance is calculated and found to be negligible at the frequencies at which these measurements are made. A.

534.232

1678. On the focusing of sound waves by a parabolic mirror. L. D. ROZENBERG. *J. Tech. Phys., USSR*, **20**, 385–96 (*April*, 1950) *In Russian.*

It is shown theoretically that for a given radius of the inlet opening of the paraboloid, maximum pressure amplification will be obtained for a mirror the depth of which is equal to its radius and the focal distance (from the apex) of which equals 1/4 of its depth. Its absolute value $= 2kf \log 5 = 0{\cdot}8\ kf$. A further optimum condition is that the focus must be a zero of velocity. B. F. KRAU

534.23

1679. An ultrasonic underwater "point source" probe. L. FEIN. *J. Acoust. Soc. Amer.*, **22**, 876– (*Nov.*, 1950).

A conically shaped piezoelectric probe of am monium dihydrogen phosphate is described. Its sensitivity over a frequency range from 1 23 to 1 280 kc/s was obtained by means of a reci procity calibration. The average value is abou $0{\cdot}12\ \mu$V/dyne/cm². Since the measured pattern o the probe as a receiver was the same at variou points in the acoustic field, it may be concluded tha the probe is a "point source." A

534.2

1680. The dependence of shadow zone sound on th surface sound velocity gradient. R. W. MORSE *J. Acoust. Soc. Amer.*, **22**, 857–60 (*Nov.*, 1950).

Consideration is given to the direct sound whic is observed to penetrate the so-called "shadow zone" of ocean acoustics. It is shown by ray theory tha the assumption that the sound velocity gradien approaches zero in the top few feet of the ocean predicts sound levels in the "shadow" which are o the same order of magnitude as those which ar measured at a frequency of 24 kc/s. A

534.2

1681. On the diffraction of a plane sound wave b a paraboloid of revolution. C. W. HORTON AN F. C. KARAL, JR. *J. Acoust. Soc. Amer.*, **22**, 855– (*Nov.*, 1950).

An infinite set of equations is obtained for th coefficients of the pressure fields inside of and outsid of the paraboloid. For the particular case of a rigi paraboloid the coefficients of the series for th scattered field can be obtained explicitly. The rati of the total pressure at the nose of the paraboloid t the pressure of the incident wave is shown as function of the shape of the paraboloid for a plan wave whose wave front is perpendicular to the axis o revolution. The same quantity is plotted for the cas of a sphere whose radius of curvature is equal to tha of the paraboloid at the nose. A

534.321.9 : 616.0

Detection of intracranial pathology by ultrasonc *See Abstr.* 2266

534.37

1682. A tuning fork filter. K. N. WULFSBERG *J. Acoust. Soc. Amer.*, **22**, 847–9 (*Nov.*, 1950).

An audiofrequency electromechanical filter using tuning fork as the resonant element is describe Q's ranging from 1 000 to 20 000 were attaine Typical response curves have been plotted and th factors that affect the Q, insertion loss and stabili are discussed.

534.3

1683. The force acting on a body moving uniform through a gas containing sound waves. F. R. N NABARRO. *Phil. Mag.*, **41**, 1270–80 (*Dec.*, 1950).

When a body travels through a gas containing a isotropic distribution of sound waves it suffers retarding force proportional to its area, to the energ

density of the sound and to its velocity. Three effects might contribute to this force: (*a*) the distribution of sound with respect to the moving body is no longer isotropic; (*b*) the apparent wavelength of the sound is altered by the motion of the body; (*c*) the non-linear terms in the equation of motion lead to a coupling between the sound waves and the steady flow of gas round the body. Effect (*c*) is shown to produce no force. Effects (*a*) and (*b*) are evaluated in the case of a sphere, and the force is shown to be expressible in terms of the force exerted by a single sound wave on a stationary sphere, already calculated by L. V. King. A.

534.39 : 615.83

1684. Physical factors involved in ultrasonically induced changes in living systems. I. Identification of non-temperature effects. W. J. Fry, V. J. Wulff, D. Tucker and F. J. Fry. *J. Acoust. Soc. Amer.*, **22**, 867–76 (*Nov.*, 1950).

The results of the first step in a systematic investigation of the mechanism of the action of ultrasound on tissue are reported. The temperature changes resulting from absorption of acoustic energy were determined while irradiation was in progress. Experimental evidence is presented which demonstrates the existence of non-temperature effects in various nerve tissue preparations. A.

534.42 : 621.389

1685. The Baldwin electronic organ. A. Douglas. *Electronic Engng*, **22**, 507–11 (*Dec.*, 1950).

A complete harmonic series is provided for each note. Each divider unit provides sawtooth pulses for all notes of one sign. Use is made of a circuit which combines two sawtooth waves to form one square wave. A series of switches is mounted below the key boards which introduces a time lag between the depressing of a key and the production of a sound. This maintains the characteristic organ sounds. Only fundamental circuits are given. W. Summer

534.62

1686. Design of echo-free rooms for acoustical measurements. O. Brandt and T. Hagman. *Tekn. Tidskr.*, **80**, 1087–92 (*Nov.* 25, 1950) *In Swedish.*

Description of the design of an echo-free room at the Kgl. Tekniska Högskolen in Stockholm. The walls are divided into squares in which are placed wedges directed into the room, horizontally and vertically in alternate squares. The (indigenous) material is Rockwool, of 65 kg/m³ density. The absorption for a given wavelength depends on the shape of the wedge, particularly on the ratio between the (prismatic) base and the tapering portion. The dimensions were chosen on the basis of absorption measurements in a 6 m long, 20×20 cm² steel tube in which a microphone was moved on a carriage, recording pressure max. and min. The room is housed independently of any other buildings and is insulated against external sound and electrical interference.

J. A. Wilcken

534.64

1687. Measurement of acoustic resistances. W. Willms. *Arch. Tech. Messen, Issue No.* 178 (*Ref.* 754–5) *T*123–5 (*Nov.*, 1950) *In German.*

Acoustic resistance and allied magnitudes (complex impedance, etc.) are first defined, and a comparison is made between analogous electrical and mechanical quantities resistance, e.m.f. pressure, current, etc. A discussion follows on the measurement of acoustical resistance by the stationary wave method. The paper concludes with a comprehensive list of references.

A. B. Wood

534.771

1688. Calibration of audiometers. E. L. R. Corliss and W. F. Snyder. *J. Acoust. Soc. Amer.*, **22**, 837–42 (*Nov.*, 1950).

A general description is given of the procedure developed at the National Bureau of Standards for calibrating audiometers. The sources of calibration standards are presented, and there is a discussion of the physics underlying the present technique. Limitations on the validity of the threshold data are pointed out. A method for determining the calibration of audiometer earphones is described. Data on earphone response can be used to gain some insight into the malfunctioning of an audiometer, and the way in which this can be done is indicated. A.

534.771

1689. The electrical and acoustical performance of some commercial audiometers. K. C. Morrical, R. W. Benson and H. Davis. *J. Acoust. Soc. Amer.*, **22**, 843–7 (*Nov.*, 1950).

The electrical and acoustical performance of a number of commercially available audiometers has been examined in the light of requirements for pure tone diagnostic audiometers recently issued by the American Medical Association and now under consideration by the American Standards Association, Inc. Performance has been judged to be satisfactory except for discrepancies at 8 000 c/s in the case of several audiometers. Likewise, it is concluded that the specifications themselves are reasonable. A.

534.78

1690. The information theory point of view in speech communication. R. M. Fano. *J. Acoust. Soc. Amer.*, **22**, 691–6 (*Nov.*, 1950).

This paper presents a non-mathematical discussion of the Wiener–Shannon theory of information. The results of this theory are used to estimate the rate of transmission of information in speech communication. A.

534.78

1691. Typology of languages. P. Menzerath. *J. Acoust. Soc. Amer.*, **22**, 698–701 (*Nov.*, 1950).

Phonemics having been atomistic, it is now completed by typology, or integral phonemics. Subjects discussed are: encoding, entropy, spelling reform; criteria for classifying a given vocabulary; monosyllabics-parallelogram; phonetic nets; frequency distribution of vowels in monosyllabic words (French, English, German). A.

534.78

1692. Description of language design. M. Joos. *J. Acoust. Soc. Amer.*, **22**, 701–8 (*Nov.*, 1950).

Physicists describe speech with continuous mathematics, such as Fourier analysis or the autocorrelation function. Linguists describe language instead, using a discontinuous or discrete mathematics called

"linguistics." The nature of this odd calculus is outlined and justified here. It treats speech communication as having a telegraphic structure. A.

534.78

1693. The relation of phonetics and linguistics to communication theory. O. H. Straus. *J. Acoust. Soc. Amer.*, **22**, 709–11 (*Nov.*, 1950).

An attempt is made by means of communication theory to build a single conceptual scheme that describes the transmission of messages from one man's brain through the medium of speech into another man's brain. It emphasizes the resemblance of speech production to an encoding process, and the resemblance of the hearing and interpreting of speech sounds to a cryptanalytic procedure that depends on the known conditional probabilities of the language. It is pointed out that speech sounds, or phones, form an infinite, continuous set, while phonemes, the smallest significant units of the cipher, are a discrete small set. It is felt that a logical method of decoding can be set up only through the convergent behaviour of language as a statistical process. A.

534.78

1694. Speech and language. J. Lotz. *J. Acoust. Soc. Amer.*, **22**, 712–17 (*Nov.*, 1950).

534.78

1695. Pathology in speech communication. I. J. Hirsh. *J. Acoust. Soc. Amer.*, **22**, 717–19 (*Nov.*, 1950).

534.78

1696. The calculation of vowel resonances, and an electrical vocal tract. H. K. Dunn. *J. Acoust. Soc. Amer.*, **22**, 740–53 (*Nov.*, 1950).

By treating the vocal tract as a series of cylindrical sections, or acoustic lines, it is possible to use transmission line theory in finding the resonances. With constants uniformly distributed along each section, resonances appear as modes of vibration of the tract taken as a whole. Thus, the fundamental mode of the smaller cavity may be affected considerably by a higher mode of the larger; and, in addition, higher resonances are found without postulating additional cavities. Dimensions for each vowel may be taken from X-ray photographs of the vocal tract. The calculations then yield at least three resonances which lie in the frequency regions known for the vowel, from analyses of normal speech. Dependence of the different resonances upon the different cavities is discussed. An electrical circuit based on the transmission line analogy has been made to produce acceptable vowel sounds. This circuit is useful in confirming the general theory and in research on the phonetic effects of articulator movements. The possibility of using such a circuit as a phonetic standard for vowel sounds is discussed. A.

534.78

1697. An apparatus for speech compression and expansion and for replaying visible speech records. F. Vilbig. *J. Acoust. Soc. Amer.*, **22**, 754–61 (*Nov.*, 1950).

In speechband compression or expansion all the frequencies of the band are divided or multiplied in a certain ratio, but without changing the time dimension. Three methods have been used: transformation of the speech frequencies into an optical spectrum and retransformation by light modulation disc and phototube; use of a string filter; use of an ultrasonic cell as a storage device. A.

534.78

1698. Spectrum analysis. F. S. Cooper. *J. Acoust. Soc. Amer.*, **22**, 761–2 (*Nov.*, 1950).

534.78

1699. System-function analysis of speech sounds. W. H. Huggins. *J. Acoust. Soc. Amer.*, **22**, 765–7 (*Nov.*, 1950).

The analysis of speech sound is facilitated if the sound is considered to be the response of a slow-time-varying linear system to appropriate excitations. The linear system is characterized by one or more system functions which may be represented most naturally as the sum of complex exponential terms having complex frequencies corresponding to the various formants. Thus, a generalized frequency analysis is made not of the speech wave itself but rather of the system function that shaped that wave. On the other hand, the excitation is best analysed by autocorrelation methods. A.

534.78

1700. Reversed speech and repetition systems as means of phonetic research. W. Meyer-Eppler. *J. Acoust. Soc. Amer.*, **22**, 804–6 (*Nov.*, 1950).

534.78

1701. Toward the specification of speech. R. K. Potter and J. C. Steinberg. *J. Acoust. Soc. Amer.*, **22**, 807–20 (*Nov.*, 1950).

An interim report on studies of the specification of speech sounds from acoustical measurements. Methods based upon analysis, synthesis and vocal tract models are described. Included are the results of preliminary measurements on the vowel sounds of 25 speakers. Some of the problems in specifying the vowel sounds as indicated by these results are discussed. A.

534.78

1702. The intelligibility of amplitude-dichotomized, time-quantized speech waves. J. C. R. Licklider. *J. Acoust. Soc. Amer.*, **22**, 820–3 (*Nov.*, 1950).

Describes two ways of reducing the normally very complicated speech wave to simple geometrical form without destroying intelligibility, reports the results of articulation tests of the simplified speech, and gives two illustrations of things that can be done more simply with the simplified than with the normal wave. Both methods of simplification involve dichotomization of the amplitude scale and then quantization of the time scale. The first step is achieved by subjecting the speech wave to infinite peak clipping, the second by generating a rectangular wave whose switchings from one amplitude level to the other are related to the switchings of the clipped speech wave by one or the other of two rules. One of the rules yields marginal intelligibility with quanta 0·2 msec in length; the other requires slightly shorter quanta. The relative merits of the two methods are accounted for by an elementary application of information theory. Autocorrelation functions, which are especially easy to compute for the simplified waves, are shown. A.

534.78

1703. Effects of delayed speech feedback. B. S. Lee. *J. Acoust. Soc. Amer.*, **22**, 824–6 (*Nov.*, 1950).

Delayed speech feedback may act as a governor of the average speed of speech operating on the phoneme unit. Certain aurally monitored manual tasks resemble the speech mechanism. The trigger-like nature of aurally monitored voice on the more rapid articulation element is described. A speech mechanism model is portrayed which satisfies phenomena of natural speech, artificial stutter, and motor aphasias.

A.

534.79

1704. Loudness balance methods for earphone response measurements. D. W. Martin and M. L. Touger. *J. Acoust. Soc. Amer.*, **22**, 833–7 (*Nov.*, 1950).

Simple procedures are given for the subjective measurement of earphone response by two methods. The first method, which is rather widely recognized, requires the subject to match the loudness of an earphone tone to the loudness of a free-field reference tone of the same frequency. Interpretation of the data from this method is direct, but the facilities, technique and time required are considerable. A second method, less widely used, involves the loudness balancing of an earphone tone of variable frequency to that of an earphone reference tone of fixed frequency and level. This method is much simpler, and can be used to measure earphone response under circumstances where the first method is virtually impossible. However, the interpretation of the data is less direct. A correspondence between the data obtained by the two methods is attempted. A.

534.833

1705. Theory of sound-proofings. I. I. Klyukin. *J. Tech. Phys., USSR*, **20**, 579–89 (*May*, 1950) *In Russian.*

Expressions of sound insulation are derived and analysed (for longitudinal waves) in a system consisting of the model of a mechanism set on elastic beddings, on a monolithic foundation or pedestal and on natural soil. The impossibility of an exact measurement, at low and medium acoustic frequencies, of the sound-proofing effect of elastic beddings without comparative tests with rigid attachment of the mechanism to its foundation is proved. Some of the causes of the reduction of the sound-proofing effect of elastic foundations at acoustic frequencies are discussed. This reduction may reach 10–15 db for a Poisson coefficient of about 0·5, which corresponds to that of rubber. B. F. KRAUS

534.833

1706. Experimental investigation of sound-proofings. I. I. Klyukin. *J. Tech. Phys., USSR*, **20**, 590–601 (*May*, 1950) *In Russian.*

A method of determining speed of sound in elastic coverings and of the dissipation factor of the latter, based on the measurement of the complex drop of the oscillation velocities on the entrance and the exit sides of a free covering, or a covering loaded with known masses. By the given method measurements in the frequency range 200–2 500 c/s of the velocity of sound were made. The dissipation factors were measured for coverings of natural and artificial rubber of varying hardness, cork, felt, bitumen and the sound-proofing characteristics of all these materials calculated therefrom. B. F. KRAUS

534.843 : 534.861.2

1707. Relation between architectural acoustics and microphonic acoustics. J. Bernhart. *Ann. Télécommun.*, **5**, 338–46 (*Oct.*, 1950) *In French.*

The author draws attention to the differences which exist in the idea of reverberation which defines the acoustic qualities of a room. The apparent reverberation via a microphone is different from the apparent reverberation of normal audition, since it lacks the well-known faculty of intelligent listening. The microphone cannot make rational discrimination between useful sound and parasitic sound. Curves are shown indicating how reverberation is affected by: volume of room; number of occupants (performers and spectators); nature of production (speech, music, theatre, opera, symphonic music, choral music, organ); frequency (for different methods of production). The position of the source of sound in the studio also affects the reverberation. Other factors which are considered are the distribution of absorbing and reflecting surfaces and the notion of directional reverberation. A. B. WOOD

534.844.4

1708. Synthetic reverberation. D. Fidelman. *Radio-Electronic Engng*, **15**, 3A–6A, 26A (*Nov.*, 1950).

The optimum reverberation times for auditoria, and for music or speech from broadcast studios, are given as a function of frequency. Several methods of obtaining controlled reverberation without the use of the appropriate room are described. One method employs an echo chamber, of $\sim 10^4$ ft^3 with glazed hard-surface walls, to provide reverberation times of 2–5 sec. Sound is introduced by loudspeakers and picked up by microphones. A cheaper technique consists of long, narrow tubes of various lengths, e.g. 25, 50, 75 and 100 ft, with loudspeakers at one end and microphones at the other. By repeated feedback, one tube can be used to give a complete reverberation with several different time-delay components. To save space, the tubes can be rolled up. These devices are being superseded by mechanically derived time delays such as multiple pick-ups on gramophone discs or on an endless magnetic-tape belt. An optical method makes use of the decay time of phosphors while another employs helical steel springs of various lengths as acoustic transmission lines. H. G. M. SPRATT

534.845.1

1709. The determination of sound absorption coefficient. J. Igarashi. *J. Phys. Soc. Japan*, **5**, 249–53 (*July–Aug.*, 1950).

Reverberation times have been measured in a concrete rectangular box, 50 cm × 46 cm × 42 cm, the effect of normal vibrations being eliminated by using thyratron noise as a source. Absorption coeffs. are determined from the results using a formula which makes allowance for the non-uniform field due to distribution of materials. A method is described of measuring normal coeffs. from the decay

time in a tube and from these the average coeffs. are determined. These are compared with the coeffs. obtained by the reverberation method. G. F. HODSMAN

OPTICS . RADIATION . SPECTRA 535

535.223

1710. A determination of the speed of light by the resonant cavity method. K. BOL. Letter in *Phys. Rev.*, **80**, 298 (*Oct.* 15, 1950).

535.223

1711. The velocity of propagation of electromagnetic waves derived from the resonant frequencies of a cylindrical cavity resonator. L. ESSEN. *Proc. Roy. Soc. A*, **204**, 260–77 (*Dec.* 7, 1950).

The cavity resonator used in this investigation is a silver-plated steel cylinder 6·5 cm dia. and of adjustable length. Resonance in the H_{011} mode is established at a frequency in the region of 9 000 Mc/s, and the length is then varied to give successive resonances at half wavelength intervals. The wavelength is thus determined and this, together with the frequency, the diameter and a correction term involving the sharpness of resonance, enables the velocity to be calculated. This procedure has some advantage over that used previously by Essen and Gordon–Smith in which the measurements were made with a resonator of fixed dimensions. The wavelength is determined only from differences in length, the first resonant length not being used, and in this way certain end-effects, such as those due to the coupling loops and to surface imperfections, are eliminated or greatly reduced. Moreover, by using different frequencies, or different modes at the same frequency, the diameter can be eliminated from the calculations and a value of c thus obtained in terms of frequency and length, both of which can be measured with high precision. The result obtained is 299 792·5 ± 3 km/sec, and is thus in close agreement with that obtained by Essen and Gordon–Smith with a fixed cavity and also with the value of c determined recently by Bergstrand with an optical method. A.

535.247.1

1712. Photographic determination of high brightness ratios. G. A. TIKHOV. *J. Tech. Phys., USSR*, **20**, 526–8 (*May*, 1950) *In Russian.*

In investigations of the energy output of the self-radiation of plants in the red and infrared range it is necessary to compare very greatly differing brightnesses, the ratio of which may be as high as several thousands. The necessity of obtaining equal densities requires the high brightness to be weakened several tens of times and the low brightness to act hundreds of times longer than the high one. Kron's formula would be the correct one to apply to the photometric comparison, but this would be too laborious in practice, all the more as a further complication resides in the fact that one of the brightnesses must be expressed in absolute units. It was thus found more suitable to use a modified Schwarzschild formula. B. F. KRAUS

535.247.4

1713. A new photometric device. J. E. TYLER. *J. Opt. Soc. Amer.*, **40**, 693–4 (*Oct.*, 1950).

Two photometric devices are described. Each of these devices employs modulated W filament lamps. In the first the lamps are electrically independent of the detector. In the second a feedback arrangement is used. These devices should prove useful for transmission or reflection measurements of neutral or coloured materials. A.

535.317.2

1714. A simple method for the determination of the focal length and principal points of an optical system. G. H. GODFREY. *Aust. J. Appl. Sci.*, **1**, 147–51 (*June*, 1950).

The method of measuring the back focal length of a lens system which is employed in the type of instrument used in ophthalmic optics and originally named a vertex refractionometer is capable of a simple extension to enable the equivalent focal length of the system to be obtained as well. The procedure combines the principles of this instrument and those of the "focometer." The method allows both positive and negative systems to be measured with equal ease. It should be of particular value wherever the ratio of the equivalent and back focal lengths is of immediate interest, as, for example, in "aniseikonic" spectacle corrections and telephoto objectives. A.

535.32:

1715. Calculation of index of refraction of gases from absorption data. M. A. GREENFIELD AND F. W. BROWN. *J. Opt. Soc. Amer.*, **40**, 643–6 (*Oct.*, 1950).

A method for computing index of refraction of gases from absorption data is described. The index of refraction for CO_2 over a wide range of frequencies was calculated and found consistent with experimental data. The index of refraction of water vapour was calculated for the frequency range 0 to 7 400 cm^{-1}. A.

535.33–15 : 536.48

1716. Effect of low temperatures on infra-red spectra. R. M. HAINER AND G. W. KING. Letter in *Nature Lond.*, **166**, 1029 (*Dec.* 16, 1950).

The breadth of bands is proportional to $T^{\frac{1}{2}}$ only when there is rotational structure, not in condensed phases; narrowing at low temp. may, however, result from depopulation of the Debye acoustic waves. Experiments on many compounds down to 4°K indicate some narrowing, but observed breadths are determined mainly by instrumental factors.

A. G. GAYDON

535.33.02

1717. The influence of argon, helium, oxygen, and carbon dioxide on emission spectra in the d.c. arc. B. L. VALLÉE, C. B. REIMER AND J. R. LOOFBOUROW. *J. Opt. Soc. Amer.*, **40**, 751–4 (*Nov.*, 1950).

A gas-tight arc stand has been constructed to study the influence of A, He, O_2, CO_2, and various mixtures of these gases on emission spectra produced in the d.c. arc. The band spectra of CN are replaced and it is found that in most lines studied the signal-to-noise ratio is better in A and He than in air. A 2 to 100-fold increase in the signal to noise ratio has been observed. It is suggested that this technique may prove useful in spectrochemistry. A.

535.33.03 : 537.52

1718. New source of light for the far ultra-violet. B. VODAR AND N. ASTOIN. Letter in *Nature, Lond.*, **166,** 1029–30 (*Dec.* 16, 1950).

Sparks along solid surfaces ("sliding sparks") can be produced under high vacuum and are a steadier source than ordinary vacuum sparks for spectra in the region 100–2 000 Å. A. G. GAYDON

535.33.07

1719. Automatic electrical control gear for the excitation and exposure of spectra. J. M. LÓPEZ DE AZCONA AND A. CAMUÑAS PUIG. *Rev. Cienc. Apl.*, **4,** 394–402 (*Sept.–Oct.*, 1950) *In Spanish.*

This device has been designed to eliminate errors due to fatigue and the human factor. The functions of the automatic gear are: to close and open the excitation circuit; to open and close the diaphragm of the spectrograph; to remove the photographic plates; to signal the end of these operations; to ignite and position the new electrodes; to interrupt instantly the programme at any given moment, automatically returning to the starting position when the finger of the timer is returned by hand to zero (the scale of the timer reads 900 sec); to interrupt all electric circuits by remote control (pulse unit); to return to the starting position in case of error (another pulsing unit). Instances of the application of this controller in research and industry are given. The characteristics of the controller are discussed. W. SUMMER

535.331 : 531.715.1

1720. Wave-lengths of mercury 198. W. F. MEGGERS AND K. G. KESSLER. *J. Opt. Soc. Amer.*, **40,** 737–41 (*Nov.*, 1950).

The wavelengths of 26 visible and u.v. radiations from Hg^{198} have been measured to 8 figures relative to 5 460·7532 Å, provisionally adopted for the green line. A water-cooled electrodeless lamp containing 2 mg of artificial Hg^{198} served as a light source when excited with radio waves of 100 Mc/s frequency. This lamp illuminated a Fabry–Perot interferometer and a large quartz spectrograph with which the interference patterns were photographed. Measurements of these patterns yielded relative wavelengths with probable errors usually less than 0·0001 Å. In addition to demonstrating that Hg^{198} 5 460·7532 Å provides a practically perfect primary standard of length, this paper presents preliminary values of 27 superior spectroscopic standards which show that differences among vacuum wave numbers recur within the accuracy of the measurements, and that all the existing dispersion curves for air are incorrect. A.

535.337

1721. Changes in *g*-values, in a spectrum, for different magnetic fields. M. A. CATALÁN AND R. VELASCO. *J. Opt. Soc. Amer.*, **40,** 653–5 (*Oct.*, 1950).

Based on the theory of the partial Paschen–Back effect a quantitative explanation is given of the fact, recently discovered by the authors, that an atomic energy level of Mn I, namely $z\,{}^6F^\circ_{1\frac{1}{2}}$, has two different values for the Landé splitting-factor g: one for each pair of the magnetic levels $M = \pm 1\frac{1}{2}$ and $\pm 0\frac{1}{2}$. Attention is called to the fact that g-values, in cases such as those observed in Mn I, experience important alterations when the magnetic field is increased from about 40 000 oersteds, which is the magnitude of fields used in the past, to about 80 000, as actually used in observing Zeeman patterns at M.I.T. for the purpose of analysing spectra. It is pointed out that if g-values accompany a list of term-designations and term-values, it is desirable to specify the magnitude of the magnetic field to verify the correctness of the designations given in the analysis of the spectrum. Otherwise any alterations which the g-values may undergo will not be correctly interpreted. A.

535.337 : 537.228.5

1722. On the Stark effect of helium in strong electric field. I. S. SUEOKA. *J. Phys. Soc. Japan*, **5,** 244–8 (*July–Aug.*, 1950).

Calculations are carried out of the wavelengths and intensities of the Stark lines in He I for very high values of the electric field. Only transitions between states with total quantum number 4 and 5 are treated numerically. Although no experimental values are available for this case, the theory accounts for the existence of the so-called resonance effects which have been observed for other transitions.

L. PINCHERLE

535.338 : 535.33.03 : 541.124

1723. Kinetic mechanisms and hydrocarbon flame spectra. R. C. HERMAN, G. A. HORNBECK AND K. J. LAIDLER. *Science*, **112,** 497–8 (*Oct.* 27, 1950).

Changes in intensity of C_2, CH and hydrocarbon flame bands (HCO) in hydrocarbon flames (particularly C_2H_2) with mixture strength and diluents, are discussed. With CO_2 as diluent there is marked enhancement of HCO, and CO flame bands appear. Detailed reaction mechanisms are suggested. HCO is produced by an exothermic addition reaction. C_2 and CH are formed by a peroxide mechanism which in its later steps is very endothermic; C_2 and CH are excited by collisions with electronically excited HCO and CO_2. A. G. GAYDON

535.338.332 : 538.615

1724. Hyperfine structure of Zeeman levels in nitric oxide. A. F. HENRY. *Phys. Rev.*, **80,** 549–52 (*Nov.* 15, 1950).

Contains a calculation of the energy arising from the magnetic interaction of the extranuclear electrons with the magnetic moment of the N nucleus in $N^{14}O^{16}$. An operator is derived for the interaction, which is more fundamental than the one, proportional to $\mathbf{I}\cdot\mathbf{J}$, commonly used. This operator is employed, together with previously calculated state functions, to compute the hyperfine structure of the $^2\Pi_{\frac{1}{2}}$ state of $N^{14}O^{16}$. The formula which results accounts for the experimental data, which cannot be explained completely if the interaction operator is taken $\propto \mathbf{I}\cdot\mathbf{J}$. A.

535.338.333

1725. Isotope shift in the atomic spectrum of carbon. C. R. BURNETT. Letter in *Phys. Rev.*, **80,** 494 (*Nov.* 1, 1950).

535.338.333 : 539.155.2 : 539.152.1

Regularities in the isotope effect in the Pb spectrum. *See Abstr.* 1971

535.338.4

1726. Perturbations in the spectrum of barium oxide. I. KOVÁCS AND A. LAGERQVIST. *Ark. Fys.*, **2**, *Paper* 38, 411–26 (1950) *In German.*

Further analysis suggests that the states perturbing the excited $^1\Sigma^*$ state of BaO [Abstr. 188 (1951)] may be $^3\Pi$ and $^3\Sigma^-$. A treatment of $^3\Pi$. $^1\Sigma^+$ perturbations is given. R. F. BARROW

535.338.4–31 : 539.132

1727. The rotational structure of the ultraviolet band system of the P_2 molecule. E. J. MARAIS AND H. VERLEGER. *Phys. Rev.*, **80**, 429–31 (*Nov.* 1, 1950).

In continuation of the investigation [Abstr. 284 (1947)] further emission bands of the u.v. band system of the diatomic P molecule have been analysed, and the vibrational and rotational constants calculated, taking the observed perturbations into consideration. A.

535.338.4–31 : 539.132

1728. The perturbations in the ultraviolet band spectrum of the phosphorus molecule P_2. S. M. NAUDÉ AND H. VERLEGER. *Phys. Rev.*, **80**, 432–5 (*Nov.* 1, 1950).

The perturbations which have been observed in the upper state of the $^1\Sigma_u^+ - {}^1\Sigma_g^+$ system of the P_2 molecule are discussed, the term values and the rotational constants of the unperturbed terms are computed, and the approximate term values and B values of the unknown perturbing terms determined. A $^3\Sigma_u^+$ and a $^1\Sigma_u^{*+}$ term have been assumed as unknown perturbing terms. A.

535.339 : 535.317.3

1729. Focal monochromator for the ultra-violet part of the spectrum. A. S. TOPORETS. *J. Tech. Phys., USSR*, **20**, 825–33 (*July*, 1950) *In Russian.*

The focal monochromator is intrinsically different from an ordinary prismatic one. The latter, like any other spectral apparatus, has 2 functions: (*a*) to disperse, and (*b*) to collect (and project, respectively) light rays. The first task is accomplished by a prism with a constant refracting angle; the projection is performed by the objective lens(es). The tendency in prismatic instruments is thus to increase the dispersion of prism, and to suppress the chromatism of the projecting system. In the focal monochromator both functions are accomplished by the same lens, whereby the error of the lens, i.e. its chromatic aberration, becomes advantageous and the need for achromatization does not arise. In the calculation of the objective for a focal monochromator, therefore, a rather unusual problem must be solved: The correction of the objective in the sense of spherical aberration must not be allowed to reduce its chromatism. The instrument described proves that, and shows how, this is possible. B. F. KRAUS

535.341–15

1730. A variable thickness low temperature infra-red cell. R. B. HOLDEN, W. J. TAYLOR AND H. L. JOHNSTON. *J. Opt. Soc. Amer.*, **40**, 757–60 (*Nov.*, 1950).

An i.r. absorption cell has been designed and constructed for use at low temperatures. This cell incorporates flat AgCl windows and possesses a mechanism for varying the sample thickness with the cell in place. The present cell is satisfactory for use down to about liquid H temperatures, but, with some minor changes, can be redesigned for use at lower temperatures. A.

535.341–31

1731. Conclusion of the study of the ultraviolet absorption spectrum of HF gas. J. ROMAND AND E. SAFARY. *C.R. Acad. Sci., Paris*, **231**, 1050–2 (*Nov.* 13, 1950) *In French.*

The variation of extinction coefficient with frequency in the region 55 000–65 000 cm^{-1} is given for 4 temperatures between 16·5° and 165°C. The figures for 165°C (with maximum absorption at 62 000 cm^{-1}) are believed to relate to HF: interpretation of the other data is complicated by association.

R. F. BARROW

535.34

1732. Study of perturbations in the spectra (0·9–1·9 μ) of saturated straight-chain hydrocarbons and ethers. G. GAUTHIER. *C.R. Acad. Sci., Paris*, **231**, 1138–40 (*Nov.* 20, 1950) *In French.*

535.343 : 535.3

1733. Absorption of resonance radiation and formation of metastable atoms in mercury vapours. L. M. BIBERMAN AND I. M. GUREVICH. *J. Exp. Theor. Phys., USSR*, **20**, 108–16 (*Feb.*, 1950) *In Russian.*

Transparency of a layer of Hg vapour for the resonance radiation has been measured at high pressures. The value of transparency passes through a minimum which has been explained by the effect of the Holtsmark dispersion broadening. Electric currents caused by the irradiation of Hg vapour have been measured. It has been found that the current strongly increases with the increase of pressure. A mechanism of this phenomenon has been suggested involving the formation of metastable atoms.

F. LACHMAN

535.343 : 539.13

1734. Quantitative study of the harmonics of the CH, CH_2 and CH_3 valency vibrations. G. GAUTHIER. *C.R. Acad. Sci., Paris*, **231**, 962–4 (*Nov.* 6, 1950) *In French.*

Frequency irregularities are interpreted in terms of resonance effects. R. F. BARROW

535.343–14 : 539.13

1735. Microwave determination of the centrifugal distortion constants of CH_3Cl, CH_3Br, CH_3I, BrCN and ICN. J. W. SIMMONS AND W. E. ANDERSON. *Phys. Rev.*, **80**, 338–42 (*Nov.* 1, 1950).

The values of B, D_J and D_{JK} in the ground vibrational state for the heavier methyl halides, and values of B and D_J for BrCN and ICN have been calculated from microwave spectroscopic measurements in the 3 to 5 mm wavelength region. The values of B_0 in Mc/s, D_J in kc/s and D_{JK} in kc/s in that order are for CH_3Cl^{35}: 13 292·95, 26·4 and 189; for CH_3Cl^{37}: 13 088·24, 27·0 and 184; for CH_3Br^{79}: 9 568·185, 11·1 and 129·4; for CH_3Br^{81}: 9 531·845, 10·7 and 129·0; for CH_3I: 7 501·310, 7·95 and 99·4. Values of B_0 in Mc/s and of D_J in kc/s are, for $Br^{79}CN$: 4 120·230 and 0·91; for $Br^{81}CN$: 4 096·804 and 0·87; for ICN: 3 225·578 and 0·88. Frequencies of observed lines are given in tables for calibration purposes.

535.343.2

1736. Spectral absorption curves of solid dye-films. A. T. VARTANYAN. *J. Tech. Phys., USSR*, **20,** 847–53 (*July*, 1950) *In Russian.*

Spectral absorption curves were taken of 24 dyes belonging to different classes on a Beckmann photoelectric spectrometer, the range being 200–800 mμ. A characteristic of nearly all the dyes investigated is the steep rise of the absorption curve in the far u.v. A strong continuous absorption in this range must be a very general phenomenon because of the superposition of the absorption of the various substituted groups taking place here. For a number of dyes a low wide maximum is characteristic, situated at or near 400 mμ. This may possibly belong to the dye molecule rather than to its ion. The relative height of the maximum due to associated molecules must depend on the ratio of the associated molecules to the non-associated ones. If in the solid film most of the molecules are associated, the secondary maximum present in the spectrum of the diluted solution takes the place of the principal maximum in the solid film. The method of deposition of the film will then affect the character of the absorption curve, and for such dyes the distribution of the bands on principal and secondary ones has an accidental character. However, as the spectral absorption curves of natural dyes (e.g. safranin T, phenol-safranin, acridine yellow and tripa-flavin) coincide in their general features, the curves obtained furnish a general picture of the absorption of many more dyes. B. F. KRAUS

535.343.2

1737. Absorption spectrum of cuprous oxide. M. HAYASHI AND K. KATSUKI. Letter in *J. Phys. Soc. Japan*, **5,** 380–1 (*Sept.–Oct.*, 1950).

535.343.31–15

1738. Qualitative studies of the absorption bands of liquid saturated aliphatic hydrocarbons in the near infra-red. G. GAUTHIER. *C.R. Acad. Sci., Paris*, **231,** 837–9 (*Oct.* 23, 1950) *In French.*

535.343.31–31

1739. Near ultraviolet absorption spectrum of liquid benzene from 2 795 to 3 560 A. A. C. PITTS. Letter in *J. Chem. Phys.*, **18,** 1416–17 (*Oct.*, 1950).

535.343.4–14

1740. Radiofrequency spectrum of D_2 in a magnetic field. H. G. KOLSKY, T. E. PHIPPS, JR., N. F. RAMSEY AND H. B. SILSBEE. Letter in *Phys. Rev.*, **80,** 483 (*Nov.* 1, 1950).

535.343.4–15

1741. Infrared spectrum of chlorofluoromethane. E. K. PLYLER AND M. A. LAMB. *J. Res. Nat. Bur. Stand., Wash.*, **45,** 204–8 (*Sept.*, 1950).

In order to compare its spectrum with that of other halogenated methanes, the infrared spectrum of chlorofluoromethane has been measured in the gaseous state from 2 to 30 microns. The longest wavelength band was observed at 26 microns. Twenty-five bands have been observed with cells of 5, 60 and 100 cm in length and with gas pressures up to 60 cm Hg. Nine of the observed bands have been classified as fundamentals, and the remaining bands are attributed to harmonics and combinations. Several bands in the region from 1·5 to 2·5 microns were measured on a high resolution grating instrument, and it was possible to resolve each of 7 bands into a series of lines in this region. These bands are located at 1·657, 1·682, 1·700, 1·755, 2·229, 2·287 and 2·436 microns; the separation of the rotational lines is of the order of 2·3 cm^{-1} for these bands. A.

535.343.4–15

1742. The infra-red spectrum of nitrosyl chloride. J. H. WISE AND J. T. ELMER. Letter in *J. Chem. Phys.*, **18,** 1411 (*Oct.*, 1950).

535.343.4–15 : 535.375.56

1743. Normal modes of ethane. T. S. G. KRISHNAMURTY AND S. SATYANARAYANARAO. Letter in *J. Chem. Phys.*, **18,** 1411–12 (*Oct.*, 1950).

535.343.4–15

1744. The vibrational energy of H_2S. H. C. ALLEN, JR., P. C. CROSS AND G. W. KING. Letter in *J. Chem. Phys.*, **18,** 1412 (*Oct.*, 1950).

535.343.4–32 : 533.27

1745. Use of compressed gases as solvents in the Schumann region. S. ROBIN, J. ROMAND AND B. OKSENGORN. *C.R. Acad. Sci., Paris*, **231,** 689–91 (*Oct.* 9, 1950) *In French.*

Argon at 500–1 000 kg/cm^2 is suggested. Details are given of successful experiments with phenanthrene, which shows absorption bands at 2 040, 1 830 and 1 635Å. R. F. BARROW

535.349.4 : 537.531.9

1746. Induced absorption bands in MgO crystals. J. P. MOLNAR AND C. D. HARTMAN. Letter in *Phys. Rev.*, **79,** 1015–16 (*Sept.* 15, 1950).

Measurements of the growth and decay of bands at 2 200, 2 850 and 5 250Å induced by 40 kV X-rays are reported. R. F. BARROW

535.371

1747. Phosphorescence decay in alcoholic solutions of some more simple compounds of the aromatic series at the temperature of liquid oxygen. O. G. ZINOVEVA. *J. Exp. Theor. Phys. U.S.S.R.*, **20,** 132–8 (*Feb.*, 1950) *In Russian.*

Phosphorescence decay of alcoholic solutions of 16 organic compounds (6 phenols, 6 aromatic hydrocarbons and 4 aromatic acids) has been investigated at the temperature of liquid O. The phosphorescence decay of these solutions follows an exponential law. Mean duration of the state of excitation of the molecules involved depends on the nature and position of substituents introduced into the benzene ring, and is not equal to the mean duration of the state of excitation for the molecules of pure substances. The luminescence colour of solutions is also different from that of the pure substances. F. LACHMAN

535.371

1748. Luminescence of NaCl monocrystals, subjected to thermal treatment. M. L. KATS. *J. Exp. Theor. Phys.*, **20,** 166–74 (*Feb.*, 1950) *In Russian.*

Investigation undertaken to check observations of Morgenshtern and others that luminescence of alkali-halide crystals annealed in air is due to penetration of a gas from ambient air into crystal. It is absent *in vacuo*, and also, if observed in air, is quenched by

subsequent vacuum-anneal. X-ray irradiation of crystals without anneal also produces luminescence in the visible spectrum. In both cases the luminescence was found to be due to liberation of electrons from the same localized energy levels, but the anneal produces a considerable intensification of the luminescence and of the total emission. It was also found that visible light converts one kind of colour centres into another of a lower activation energy. Further experiments were made on powdered monocrystals, with the result that, whilst it also produces a considerable intensification of the luminescence, this is not as strong as that obtained by anneal. In addition, the character of the curves of thermal luminescence is different in both cases; the maxima of the "powder curve" are fainter and flatter than those of the annealed monocrystal. Author adds a comprehensive discussion of the phenomenological theory of the conversion of the F centres into F' centres.

B. F. KRAUS

535.371

1749. The fluorescence of magnesium germanate activated by manganese. F. A. KROEGER AND J. VAN DEN BOOMGAARD. *J. Electrochem. Soc.*, **97**, 377–82 (*Nov.*, 1950).

Magnesium germanate activated by manganese may contain the activator in different valencies. When this valency is higher than 2, fluorescence excited by u.v. occurs in 7 narrow bands decaying with the same time constant. The variation of this decay constant and the intensity of fluorescence with temperature is explained by the assumption that the relative contribution of radiative and non-radiative transitions is determined by a Boltzmann equilibrium regulating the population of various excited states. A.

535.371

1750. Solid non-crystalline scintillation phosphors. M. G. SCHORR AND F. L. TORNEY. Letter in *Phys. Rev.*, **80**, 474 (*Nov.* 1, 1950).

535.371

1751. Some rare earth activated phosphors. H. G. JENKINS AND A. H. MCKEAG. *J. Electrochem. Soc.*, **97**, 415–18 (*Dec.*, 1950).

Two classes of rare earth activated phosphors having interesting and unusual properties are described. The first series, consisting of alkaline earth silicates activated by divalent Eu, shows a wide range of fluorescent colours when excited by 3 650Å radiation. Some of these compounds are characterized by the stability of their fluorescence at comparatively high temperatures. The second class, consisting of alkaline earth pyrophosphates activated by Dy and Sm, has unusual phosphorescent characteristics when excited by cathode rays. A.

535.371

1752. Luminescence and trapping in zinc sulfide phosphors with and without copper activator. R. H. BUBE. *Phys. Rev.*, **80**, 655–66 (*Nov.* 15, 1950).

A comprehensive study of ZnS : [Zn] and ZnS : [Zn] : Cu phosphors has been carried out with the use of glow curves, phosphorescence-emission decay curves, and spectral distribution curves of emission during excitation by 3 650Å u.v. The principal contributions of the study are: glow curves and spectral emission curves for 9 samples each of cubic and hexagonal ZnS with Cu activator in proportions from zero to 3 000 parts per million; a direct proof for ZnS-type phosphors of the equation of trap emptying proposed by Randall and Wilkins; a detailed extension of the study of retrapping by the method indicated by Wilkins and Garlick; a determination of the number of electron traps in ZnS as a function of heating temperature in preparation; an analysis of glow and decay curves by means of the equation of Randall and Wilkins; suggestions concerning the identity of traps and luminescence centres on the basis of a study of the crystal structures of cubic and hexagonal ZnS. A.

535.371.07

1753. The adhesion of phosphors on cathode-ray screens. W. STERICKER AND F. HAZEL. *J. Phys. Coll. Chem.*, **54**, 1045–53 (*Oct.*, 1950).

In the method of producing cathode-ray screens on glass surfaces by the settling of aq. suspensions of ZnS or Zn silicate phosphors (particle size 5–15 microns), electrical and chemical effects are important during the settling period, but the primary cause of adhesion is the bridge formed by polymerization of the silicate adsorbed on the glass and on the phosphor surfaces. With suspensions in distilled water the phosphor settles uniformly in a few minutes, and then remains unaltered. With suspensions in aq. K_2O, 3·92 SiO_2 solutions, however, the uniformity of the layer decreases on standing owing to migration of the deposit under the action of gravity. These varying adhesion results may be correlated with the δ-potentials of the phosphors and pyrex glass surfaces. Addition of Na_2SO_4 to the silicate solution promotes adhesion between the glass and the phosphor. J. GRANT

535.372

1754. Calculation of the absorption and emission spectra of the thallium-activated potassium chloride phosphor. F. E. WILLIAMS. Letter in *Phys. Rev.*, **80**, 306–7 (*Oct.* 15, 1950).

535.375.5

1755. On the lattice frequencies of 1,2-dihalogenoethanes. I. ICHISHIMA AND S. MIZUSHIMA. Letter in *J. Chem. Phys.*, **18**, 1420 (*Oct.*, 1950).

535.375.5

1756. Apparatus for low temperature study of the Raman effect. R. C. LORD AND E. NIELSEN. *J. Opt. Soc. Amer.*, **40**, 655–7 (*Oct.*, 1950).

A simple modification of a conventional excitation unit for the Raman effect is described that allows study of the effect in liquids at temperatures down to about − 150°C. The chief feature of the arrangement is a Dewar-jacketed sleeve that fits around the Raman tube and enables the cooling of the tube by a flow of cold N gas. By adjustment of the temperature of the gas and its rate of flow, easy and precise control of the temperature of the Raman tube can be obtained. It is also possible to use elevated temperatures (up to + 150°C) by heating the N. The advantages of the system are its simplicity, ease of operation, rapidity of change from low temperature to normal operation and vice versa, and the same intensity of illumination as that afforded by room-temperature operation. A.

535.375.55

1757. The Raman spectrum of tetrafluoroethylene in the condensed phase, with further assignment of the fundamental frequencies. A. MONFILS AND J. DUCHESNE. Letter in *J. Chem. Phys.*, **18**, 1415 (*Oct.*, 1950).

535.375.56

1758. On an abnormality of the intensity ratio of the Stokes and anti-Stokes frequencies in the Raman spectrum of CCl_4 excited by photons of low energy. H. STAMMREICH, O. SALA AND R. FORNERIS. *An. Acad. Brasil. Cienc.*, **22** (*No.* 3), 307–16 (1950) *In Portuguese.*

The experiments were carried out at 303°K. In the Raman spectrum of CCl_4 there was a deviation from normal of the intensity ratio of Stokes and anti-Stokes frequencies when the spectrum was excited by the radiation He 3 D^3–2 P^3 ($\lambda = 5\,875{\cdot}6$Å). The anti-Stokes frequencies are stronger than was expected. The ratios between the theoretical values and the mean values, derived from a large series of experiments, are: 1·10 for $\omega_1 = 217\ cm^{-1}$; 1·37 for $\omega_2 = 313\ cm^{-1}$; and 1·56 for $\omega_3 = 459\ cm^{-1}$, where ω is the vibrational frequency given by the wave number.

W. SUMMER

535.375.56 : 535.343.4–15

Normal modes of ethane. *See Abstr.* 1743

535.376

1759. Effect of temperature rise on the phenomena of electrophoto-luminescence. G. DESTRIAU AND J. MATTLER. *J. Phys. Radium*, **11**, 529–41 (*Oct.*, 1950) *In French.*

Sulphide phosphors exposed to an a.c. field while under continuous X-ray or u.v. excitation, show an instantaneous quenching followed by a rise to a new level of brightness lower than the original. The effects of temp. rise up to ~ 75°C are described. In particular the degree of permanent quenching increased with increase of field strength, and for ZnCdS.Ag phosphors also with rise of temp., but ZnS.Cu phosphors were little affected by temp. change. The results suggest an analogy with i.r. quenching rather than with thermal quenching. Some sulphides showed a fugitive emission in the electric field applied after exposure to X-rays (or u.v. or α-particles). The light sum so produced was a max. for a certain dose of radiation at constant temp., and occurred at ~ 35°C for a constant dose. The max. sum was reached at a smaller dose as temp. increased. From the assumption that the deactivation of metastable states has its origin in a general ionization of the lattice (by X-rays), a theory of the process is developed in agreement with experiment. The instantaneous increase of brightness of ZnS.Cu which occurs on switching the field on and off is also described with reference to temp. effects. S. T. HENDERSON

535.379 : 536.46

1760. Thermal radiation and chemiluminescence from explosion flame gases. A. S. LEAH, J. GODRICH AND H. R. S. JACK. Letter in *Nature, Lond.*, 868–9 (*Nov.* 18, 1950).

CO-air mixtures were ignited, by a spark at one end, in a tube 5 in dia. and 7 ft long, which was closed by a hemispherical cap; the other end was open to the atmosphere during the combustion process. The flame front expanded spherically until its dia. was almost that of the tube. By means of a Cu-wire bolometer mounted behind a fluorite window in the tube wall, the variation with time of the total radiation emitted by the spherical flame was recorded on a c.r. oscillograph; resistance thermometers were used to record the flame temp. (at various radii from the centre of ignition) on the same trace. It was shown that when the flame had travelled down the whole length of the tube to the open end, chemical reaction at the igniting end was complete, so that radiation from that region was then purely thermal. Measurement of the gas-temp. and radiated energy under these final conditions enabled an estimate to be made of the thermal radiation in the early (spherical) stages of flame propagation. It was found that thermal radiation accounts for only a very small part of the total radiation from CO-air mixtures (whether wet or dry), the main source of radiant energy being chemiluminescence. The flame temps. recorded were very low, from 100–300°C for a dry mixture and 300–700°C for a wet mixture; the low values are explicable if the thickness of the reaction zone is $\geqslant$ the explosion tube dia. In the case of CO-O_2 and CS_2-air mixtures chemiluminescence again occurs, but its effect is relatively less than in CO-air mixtures because higher flame temps. are attained. A. SCHOFIELD

535.39

1761. Absorption of near-infrared energy by certain glasses. J. M. FLORENCE, C. C. ALLSHOUSE, F. W. GLAZE AND C. H. HAHNER. *J. Res. Nat. Bur. Stand., Wash.*, **45**, 121–8 (*Aug.*, 1950).

An analysis has been made by calculation of the internal transmittances and surface losses. The wavelengths, in microns, associated with broad absorption bands have been measured, and the active vibrating groups causing the absorption are as follows: 2·7, CO_2; 2·75, OH; 2·75, CO_2; 2·9, OH associated; 3·5, CO_3^{--}; 3·65, (NO_3^-); 3·8, Si–O bond; 4·0, CO_3^{--}; 4·15, (NO_3^-); 4·25, CO_2; 4·45, Si–O bond; and 4·7, OH associated. The greatest loss of infrared energy for a number of glasses is caused by surface losses, rather than by true internal absorption. A.

535.39

1762. An experimental study of the change in phase accompanying reflection of light from thin evaporated films. L. G. SCHULZ AND E. J. SCHEIBNER. *J. Opt. Soc. Amer.*, **40**, 761–5 (*Nov.*, 1950).

The phase change was measured for 3 different cases: front surface deposits of Ag on glass; back surface deposits of Ag and Au on glass; front surface deposits of dielectrics on nearly opaque Ag layers. In all three cases the phase change was determined as a function of the thickness of the deposit. When the deposits exceeded several hundred ångstroms the results were consistent with boundary value solutions of the equations of electromagnetic theory but for thinner deposits they are explained by light scattering rather than reflection from uniform layers. From index of refraction determinations it was found that films of cryolite and MgF_2 were non-porous but that CaF_2 was highly porous. Very thin films of ZnS showed density anomalies. A.

535.39 : 535.417

1763. An interferometric study of some optical properties of evaporated silver films. R. C. FAUST. *Phil. Mag.*, **41**, 1238–54 (*Dec.*, 1950).

Thermally evaporated Ag films have been studied in the reflectivity range of 4 to 95%. The air-Ag and glass-Ag reflection and transmission coefficients, the corresponding reflection phase changes and the apparent film thickness have been measured and compared with those of sputtered Ag films. For very thin films, in a region where the light absorption is high, the glass-Ag reflection coefficient passes through a minimum, and in the yellow and the green, but not in the blue, the glass-Ag reflection phase change suddenly alters from an advance to a retardation. This transition in the phase change is intimately associated with the reflected fringe asymmetry. A.

535.39 : 771.535

1764. On the character of light absorption in silver halide layers. B. BARSHCHEVSKIĬ. *J. Exp. Theor. Phys*, **20** (*No.* 2) 117–26 (1950) *In Russian.*

Absorption of light of 254–578 mμ was investigated for polycrystalline layers 10^{-5}–10^{-6} cm thick of AgCl, AgI, AgBr and for monocrystalline layers of the same salts of thickness 10^{-3}–10^{-4} cm. Polycrystalline layers were prepared by evaporating Ag metal under vac. on to quartz plates which were then exposed to Cl, Br or I vapour. Monocrystalline layers were formed by pouring molten Ag between two quartz plates. It was found experimentally for both the poly- and mono-crystalline layers that each layer had a characteristic value for the absorption coeff. as defined by Lambert's law $I = I_0 e^{-kd}$, and for layers differing appreciably in thickness the values differed by many hundreds. Lambert's law is therefore inapplicable to thin layers since absorption is relatively high in the very thin surface layers particularly for u.v. λ's. The high absorption in the surface layers is explained by the presence of an appreciable internal photoeffect. This photoeffect and the consequent light absorption explain the formation of the latent photographic image chiefly on the surface of microcrystals ("grains") of the photographic emulsions and explains the fact that the magnitude of the quantum yield η is less than 1 when determined by the photoelectric method. W. HUGHES

535.41

1765. The limitations of the principle of superposition. P. R. HEYL. *J. Wash. Acad. Sci.*, **40**, 345–7 (*Nov.* 15, 1950).

Since energy is proportional to the square of the amplitude, addition of amplitudes of oscillations may lead to apparent violations of the principle of conservation of energy, unless phase is also taken into account. The author suggests a more general method of compounding oscillations, in which energy is regarded as fundamental, and factors applied to the amplitudes. Author claims that correct results given by traditional methods are due to repeated errors which compensate each other. N. CORCORAN

535.417

1766. A method for the adjustment of the compensator plate of a Michelson interferometer. J. E. H. BRAYBON. *J. Sci. Instrum.*, **27**, 331–2 (*Dec.*, 1950).

The method is a modification of the usual interference method of adjustment for parallelism between compensator and splitter plates of a Michelson interferometer. Adjustment is made by reducing to zero the fringes obtained when a spectrometer is used to analyse white light which has passed through the interferometer arm containing the compensator. Parallelism may be assessed to within $0{\cdot}2'$ of arc. A.

535.417 : 531.715.1

1767. An interferometric method for accurate thickness measurements of thin evaporated films. L. G. SCHULZ. *J. Opt. Soc. Amer.*, **40**, 690–2 (*Oct.*, 1950).

A method is described in which a Fabry–Perot interferometer is used to measure the thickness of uniform thin films to an accuracy of $\pm$ 15Å. The separation of the *D*-lines of Na light is used as a standard of length. The method is evaluated by comparison with other methods and in terms of its applications and limitations. A.

535.417 : 539.234 : 531.715.1

1768. An experiment on 16 times amplification of the phase-shift of thin films. K. ISHIGURO. Letter in *J. Phys. Soc. Japan*, **5**, 380 (*Sept.–Oct.*, 1950).

A description has been given earlier [Abstr. 228 (1951)] of a double slit interference method for the measurement of the thickness of a thin film deposited on glass. It is shown how a judicious arrangement of the geometry of the deposited film, relative to the slits permits an increase in sensitivity by a factor of $\times 16$. For a surface wiped with silicon oil paper lens-cleaner a film thickness of 60Å is reported. S. TOLANSKY

535.42 : 535.315

1769. Diffraction pattern deterioration by roof prisms. A. I. MAHAN AND E. E. PRICE. *J. Opt. Soc. Amer.*, **40**, 664–86 (*Oct.*, 1950).

Assuming a rectangular limiting aperture, the deterioration consists of a doubling of the diffraction pattern in a direction perpendicular to the roof edge. Parallel to the roof edge no deterioration of the diffraction pattern takes place so that in this direction it is always of the Fraunhofer form. If plane polarized light is allowed to enter these prisms, the form of the doubling perpendicular to the roof edge can be changed by rotating the incident azimuth angle of the entering plane polarized light. Usually such a doubling is associated with an error in the roof angle. The theory in this and the previous paper [Abstr. 439 (1946)] predicts a doubling of the diffraction pattern in a direction perpendicular to the roof edge even for a prism with a perfect 90° roof angle. The theory in this paper is simplified so that for prisms with uncoated reflecting surfaces the diffraction pattern form can be calculated for a 2 or 3 internal reflection roof prism knowing only of the angular deviation at the roof edge, the prism refractive index, and the entering azimuth angle of plane polarized light. Experimentally it was found that silvering the roof surfaces for two different forms of prisms decreased the doubling of the diffraction pattern perpendicular to the roof edge. It is possible to calculate also the diffraction pattern forms for roof prisms with coated reflecting surfaces providing the refractive index and absorption index of the coating material are known. A.

535.42 : 535.824

1770. The black and white hologram. G. L. ROGERS. Letter in *Nature, Lond.*, **166,** 1027 (*Dec.* 16, 1950).

A previous analogy suggested between zone-plate and hologram (see Abstr. 8667 (1950)] has led to the use of a black-and-white representation of the hologram. This is obtained by inking in the main fringes on a photograph and then removing the silver image. A recognizable reconstruction is still obtained from this ink drawing. R. W. FISH

535.421

1771. Refraction gratings. E. HULTHÉN. *Ark. Fys.*, **2,** *Paper* 41, 439–41 (1950).

Refraction gratings have the diffraction occurring in a transparent medium of high refractive index. The "blaze" is then shifted into a higher order. Increases in intensity of 10× were obtained experimentally in the 4th order. A liquid between a front surface grating and a parallel glass plate can be used but this leads to loss of definition probably owing to inhomogeneity in the liquid. A better method uses a glass plate wedged slightly to remove multiple reflections. The grating is ruled on the under surface and aluminized. For coarse ruled echelle gratings a prismatic arrangement is used as the "blaze" occurs at glancing angles. R. W. FISH

535.421

1772. Use of diffraction gratings ruled on cylinders. T. R. MERTON. Letter in *Nature, Lond.*, **166,** 866 (*Nov.* 18, 1950).

535.422

1773. Light distribution near focus in an error-free diffraction image. E. WOLF. *Proc. Roy. Soc. A*, **204,** 533–48 (*Jan.* 9, 1951).

Expressions are derived for the fraction of the total illumination present within certain regions in receiving planes near focus of spherical waves issuing from a circular aperture. The derivation is based on Lommel's treatment of Fresnel diffraction, and the solution takes the form of rapidly convergent series involving Bessel functions. Numerical results are illustrated by contour lines. The distribution of the illumination in a number of selected planes near focus is studied in greater detail. A comparison with the predictions of geometrical optics is also made. As a special case the fraction of the total illumination present in the geometrical shadow is discussed. The results provide a mathematical basis for a discussion of the imaging properties in optical systems where, as for example in a well-corrected refracting telescope objective, the chromatic variation of focus is the only appreciable aberration. A.

535.43 : 548.0

1774. On the Rayleigh scattering of crystals. J. CHAPELLE AND A. GALY. *C.R. Acad. Sci., Paris*, **231,** 868–70 (*Oct.* 23, 1950) *In French.*

A simple way of calculating the Rayleigh scattering with Kastler's [*J. Chem. Phys.*, **46,** 39–48 (1949)] qualitative considerations as a starting point. This can be used in more complicated cases. The theoretical results are tested on a synthetic NaCl crystal and found satisfactory. C. TURNER

535.434

1775. Study of the optical properties of shellac solutions. S. BASU. *J. Phys. Coll. Chem.*, **54,** 1358–66 (*Dec.*, 1950).

The results of the measurements of the depolarization of transversely scattered light by solutions of shellac in different solvents and at different concentrations are consistent in indicating that the scattering units are fairly large compared to the wavelength of light; they first diminish and then increase in size with concentration. The results are best explained by assuming the existence of anisotropic scattering units, similar in nature to the cybotactic groups in liquids, which interlock at higher concentrations and give a continuous structure at the gel point. Behaviour in single solvents as also in mixed solvents containing a component with one polar group is exactly similar. If one component is bipolar the anisotropic character has been found to increase at about 40% concentration of shellac. A tentative explanation for this phenomenon has been given. A.

535.434 : 532.712 : 541.64

1776. Comparison of molecular weights of polystyrene by the light-scattering and osmometric methods. Q. A. TREMENTOZZI. *J. Phys. Coll. Chem.*, **54,** 1227–39 (*Nov.*, 1950).

The molecular weights of polystyrene fractions were determined by the light-scattering and osmometric methods and found to be in good agreement up to a molecular weight of approximately 700 000. Beyond 700 000 the effect of the solvent on the size of the dissolved polymer molecules is critical, so that there is no agreement in the molecular weight obtained with polar solvents as compared to molecular weights obtained with nonpolar solvents. These discrepancies in molecular weights for the species of very high molecular weight appear to be due to the anomalous behaviour of the polymer molecules in solution in the different solvents rather than to the method employed in making the measurements. A.

535.434 : 541.64

1777. Photoelectric light-scattering photometer for determining high molecular weights. B. A. BRICE, M. HALWER AND R. SPEISER. *J. Opt. Soc. Amer.*, **40,** 768–78 (*Nov.*, 1950).

For molecular weight determination by measurement of absolute turbidity, dissymmetry and depolarization of dilute solutions of high molecular weight materials. The photometer comprises essentially a monochromatic parallel primary beam of radiation, a six-sided scattering cell for measurements at 0°, 45°, 90° and 135°, a multiplier phototube and galvanometer, a standard opal glass diffusor, and removable polarizer and analyser. Turbidity is determined in terms of a ratio of deflections for the 90° scattering and for the primary beam reduced in intensity by neutral filters and diffused by an opal glass plate. Working relationships leading to determination of absolute turbidity are developed. These relationships include corrections for refraction and reflection effects, and for imperfect diffusion by the opal glass. The latter is evaluated by comparison of the opal glass with reflecting diffusors corrected for specular component of reflectance. The response of

some multiplier photo-tubes is shown to be dependent on the plane of polarization of the incident radiation. Data illustrating the performance of the photometer include comparison of molecular weights of polystyrene fractions, beta-lactoglobulin, bovine serum albumin, lysozyme, sucrose octaacetate, Rayleigh's ratio and depolarization for benzene, turbidity of a "standard" polystyrene and particle size of a *GR-S* latex, with data obtained by other methods or other investigators. A.

535.435

1778. The influence of absorption on the intensity of light scattered by liquids. J. TONNELAT AND H. BATSCH. *C.R. Acad. Sci., Paris*, **231**, 960–2 (*Nov.* 6, 1950) *In French.*

Enlarging on the theory of Caspersson [*Kolloid Z.*, **65**, 162–70 (*Nov.*, 1933)] who calculated the intensity in absorbing liquids for observation at right angles to the surface, the intensity is calculated in all directions of observation assuming that the scattering is small, so that secondary scattering can be neglected.

C. TURNER

535.54 : 535.6

1779. Electrical color filters. V. BABITS AND H. F. HICKS, JR. *Electronics*, **23**, 112–15 (*Nov.*, 1950).

Filters are described which are electrically or magnetically controlled. A device that is, or can be made, doubly refracting is placed between two polarizing devices. When white light is passed through the system the colour of the emergent light depends on the phase difference introduced by the doubly-refracting device. This phase difference can be varied and with it the colour. The variation is produced either electrically by the Pockels and Kerr effect or magnetically by the Faraday and Cotton–Mouton effect. The magneto-optic Kerr effect can also be used. The application of two such systems in series is discussed and the possibility of use for coloured motion pictures, colour facsimile transmission systems and in colour television mentioned.

H. G. JERRARD

535.55 : 539.215.9

1780. Photo-elastic method for determination of stress in powdered mass. T. WAKABAYASHI. Letter in *J. Phys. Soc. Japan*, **5**, 383–5 (*Sept.–Oct.*, 1950).

535.581 : 535.343 : 539.133

1781. Rotary dispersion of metallic oxymethylene-camphor complexes. I. LIFSCHITZ. *Rec. Trav. Chim. Pays-Bas*, **69**, 1495–1503 (*Nov.*, 1950) *In German.*

Rotary dispersions, absorption spectra, and dipole moments of the oxymethylene camphorates and acetylacetonates of Al, Cr, Co and Fe are recorded and discussed, with particular reference to racemization.

C. B. ALLSOPP

535.6 : 621.327.43

1782. Fluorescent lamp artificial daylight units for colour matching. G. T. WINCH, W. HARRISON AND H. R. RUFF. *Trans. Illum. Engng Soc., Lond.*, **16** (*No.* 1) 1–12 (1951).

The colour and colour-rendering characteristics of natural daylight are considered together with the requirements for artificial daylight sources for critical colour-matching purposes. The development of artificial daylight units utilizing tubular fluorescent electric discharge lamps is shown to follow two main lines: (*a*) a combination of fluorescent powders in either hot or cold cathode fluorescent lamps, and (*b*) a combination of radiation from fluorescent lamps and groups of incandescent tungsten filament lamps. Practical tubular fluorescent daylight colour matching units using cold cathode tubes are in use in industry for critical colour matching purposes, whilst experimental hot cathode lamps have been used in some prolonged field tests. An alternative method being investigated is to combine blue fluorescent lamps with incandescent tungsten filament lamps. This provides a closer approximation to black-body spectral distribution than at present possible with fluorescent lamps alone, provided care is taken to ensure adequate mixing of the light, and adjustment is made for the differential life behaviour of the component lamps. The outstanding advantage of artificial daylight units incorporating tubular fluorescent lamps is their high efficiency (of the order of 30 lm/W) which enables a very much higher illumination to be obtained over large working areas than has previously been practicable with filtered tungsten light or light from daylight units incorporating CO_2 tubes. A.

535.683

1783. Photochromism in the bianthrone series. Y. HIRSHBERG. *C.R. Acad. Sci., Paris*, **231**, 903–4 (*Oct.* 30, 1950) *In French.*

If a solution of bianthrone is irradiated with radiation of λ3650 Å at $-60°$ its green colour changes to brownish-red. The effect is observed even after only 1 min of irradiation. It is reversible; when the solution is heated to ordinary temp. the original colour is restored. Xanthylidene-anthrone, and 4 : 4′-substituted bianthrones also show the same behaviour. A. J. MEE

535.8

1784. A method of producing short impulses of light. S. M. RAĬSKIĬ AND E. YA. PUMPER. *J. Tech. Phys., USSR*, **20** (*No.* 7) 822–4 (1950) *In Russian.*

A simple linear-motion slotted shutter producing periodic groups of light impulses is described. The duration of the individual impulse may be as short as 10^{-7} sec, and the interval between two consecutive impulses of the same order. The impulses were recorded by a c.r.o. controlled by a photocell.

B. F. KRAUS

535.822.9 : 535.417

1785. An interferometer microscope. J. DYSON. *Proc. Roy. Soc. A*, **204**, 170–87 (*Dec.* 7, 1950).

Some of the drawbacks of conventional phase-contrast microscopy are enumerated and the desirability of an interferometer microscope is indicated. A number of existing ways of achieving this are described, together with their merits and drawbacks. A new type of interferometer microscope which avoids some of these disadvantages is described, together with its operational procedure. The conditions covering coherence in the object plane are investigated and a simple approximation for evaluating the coherence is derived. An elementary discussion of contrast arising from phase or amplitude objects is given, and a number of experimental results are

presented as photo-micrograms. Finally, a method for the accurate measurement of the optical thickness of an object is described, with the results of a determination of the refractive index of the cytoplasm of epithelial cells. A.

535.825.3

1786. A low-temperature microscope stage. R. G. RHODES. *J. Sci. Instrum.*, **27**, 333–4 (*Dec.*, 1950).

A simple "cold chamber" is described for the optical observation of crystals below room temperature, under conditions relatively free from frosting. It is designed for the polarizing microscope with objectives up to ×20. The low temperatures are obtained by means of cooling gas from the evaporation of liquid air and they can be regulated to within 0·1°c down to −140°c by manual control of the heating elements. A.

535.833 : 535.249

1787. The influence of the Stiles–Crawford effect on telescope luminosity. M. T. ZOLI. *Atti Fond. "Giorgio Ronchi,"* **5**, 245–50 (*Oct.*, 1950) *In Italian.*

The luminosity of some telescopes has been determined with a Ronchi's diaphanometer measuring the threshold of visibility for different series of the exit pupil. Plotting the telescope's luminosity against the diameters of the exit pupil, diagrams are obtained which are compared with those of the Stiles–Crawford effect, integrated in a suitable way. The agreement of the results is very good for one observer but not for another. The measurements are being continued with other observers. A.

535.89

1788. Ultraviolet radiation of the high pressure xenon arc. W. A. BAUM AND L. DUNKELMAN. *J. Opt. Soc. Amer.*, **40**, 782–6 (*Nov.*, 1950).

The u.v. characteristics of a 0·5 kW d.c. arc through high-pressure Xe were investigated. The lamp has a quartz envelope and contains pure Xe under a pressure of roughly 20 atm. when operating; its general characteristics have been described by Schulz. The absolute spectral radiance between 2 000 Å and 5 000 Å was measured photographically by comparison with the positive crater of a spectroscopically pure carbon arc. An u.v. radiance contour map of the arc stream was obtained by analysis of direct photographs. It was found that the lamp radiates a smooth u.v. continuum, which extends to the air cut-off and is interrupted by only a few weak lines. The radiance of the central spot exceeds that of the carbon crater by a factor of 23 at 2 500 Å, 12 at 3 000 Å, and 6 at 3 500 Å. Comparison with other u.v.-continuum sources shows the Xe arc to be unusually intense. A.

535.89 : 537.523.4

High intensity short duration spark light source. *See Abstr.* 1859

535.89 : 537.525.5

1789. A study of the short duration, high intensity, electric arc as a source of visible light. G. D. HOYT AND W. W. MCCORMICK. *J. Opt. Soc. Amer.*, **40**, 658–63 (*Oct.*, 1950).

A study has been made of the dependence of the peak intensity and the duration of the visible light, from arcs of a few μsec duration in Xe, Kr and A, on the input energy, the circuit characteristics, the gas and the pressure. With input energies up to about 6 joules per discharge, peak currents ranging from a few hundred up to nearly 5 000 amp have been recorded and the relation between the current and the intensity and duration of the light is specified. The dependence of both the current and the arc resistance upon several variables is discussed. A.

535.89 : 535.6

1790. Measurement, representation and specification of colour and colour rendering properties of light sources. G. T. WINCH AND H. R. RUFF. *Trans. Illum. Engng Soc., Lond.*, **16** (*No.* 1) 13–25 (1951).

The problem is stated and is followed by a description of methods of measuring and specifying colour and colour rendering properties, with particular reference to tubular fluorescent lamps. It has been found desirable in Great Britain to specify the colour characteristics of these light sources in terms of both their colour rendering properties expressed as percentage luminance in 8 spectral bands, and their colour appearance in C.I.E. chromaticity co-ordinate limits. Typical forms of colour and spectral band specification are indicated, and a preferred form of block diagram is shown in which the percentage luminance values in the 8 spectral bands are plotted on logarithmic ordinates. New and more accurate measuring apparatus is described, to enable lumens, trichromatic co-ordinates and luminance in 8 spectral bands to be measured directly on the C.I.E. system in quick succession in the one apparatus. The accuracy of such precision instruments may make it possible ultimately to specify colour rendering properties in terms of percentage luminance in spectral bands alone. A.

HEAT 536

536.2

1791. Theoretical considerations on the conduction of fluctuating heat flow. A. H. VAN GORCUM. *Appl. Sci. Res.*, **A2** (*No.* 4) 272–80 (1950).

For two cases, where there is a variable flow of heat in a wall, a proof is given that the wall can be considered as a passive four-pole. A.

536.2

1792. On the mathematical analysis of the problem of the conduction of heat when emissivity is variable. T. SATOH. *J. Phys. Soc. Japan*, **5**, 253–4 (*July–Aug.*, 1950).

The emissivity at the end of a semi-infinite line varies with time. An integral equation is found for the temperature at the end. Asymptotic properties of the temperature and emissivity are deduced.

S. MICHAELSON

536.21 : 548

1793. Effect of neutron irradiation on the thermal conductivity of a quartz crystal at low temperature. R. BERMAN, P. G. KLEMENS, F. E. SIMON AND T. M. FRY. Letter in *Nature, Lond.*, **166**, 864–6 (*Nov.* 18, 1950).

536.212.2 : 536.48

1794. The thermal conductivity of tin, mercury, indium and tantalum at liquid helium temperatures. J. K. HULM. *Proc. Roy. Soc. A*, **204**, 98–123 (*Oct.* 24, 1950).

An account is given of a method of employing differential gas thermometers to measure the thermal conductivity of metals at low temperatures, with temperature differences of only 0·02°K in the specimen. Experimental curves are presented showing the variation of thermal conductivity with temperature between 1·7 and 4·3°K for pure Sn, alloys of Sn with Hg, pure Hg, alloys of Hg with Cd and In, pure In and pure Ta, in both superconducting and normal states. The normal conductivity of strain-free specimens containing less than about 0·1% of impurity appears to be mainly electronic, and to behave roughly in accordance with the theory of Wilson, although notable discrepancies arise in the detailed application of this theory. The ratio of superconducting to normal thermal conductivity varies with temperature roughly in the manner suggested by Heisenberg when the electrons are mainly scattered by impurities, but follows a radically different curve, for which no theoretical explanation is yet available, when lattice vibrations are the dominant scattering mechanism. For impurity contents greater than 0·1%, or severe internal strains, the normal thermal conductivity contains an appreciable lattice component. A.

536.212.3

1795. Method of determining the thermal diffusivity of poor conductors of heat. L. MATTAROLO. *Nuovo Cim.*, **7**, 809–15 (*Oct.*, 1950) *In Italian.*

Examines the possibility of determining the thermal diffusivity of insulating or semiconducting materials by a new method, consisting in measuring the cooling or heating rates in samples of a simple geometric shape (spheres or cubes), in which boundary conditions are not fixed as is usually the case, but are substituted by functions of time. Some experimental results are reported. A.

536.22

1796. On heat conductivity in liquids. A. W. LAWSON. Letter in *J. Chem. Phys.*, **18**, 1421–2 (*Oct.*, 1950).

An equation of the form $K \sim C\delta^{-1}[(S/v_T) + (\delta/v_S)]^{-1}m$ is suggested for the variation of thermal conductivity in liquids. It is a combination of those proposed by Bridgman, Kittel and Kincaid and Eyring; and may be interpreted as endowing the available volume with a gas-like resistivity, in series with which is the resistivity of the imperfectly rigid but elastic molecule. C is the specific heat per unit mass, δ is the interatomic distance, S is the free path in the available volume, m is the molecular weight. The term δ/v_S is the time required for the momentum transfer to take place during a collision. E. H. DOCK

536.413 : 536.631

1797. Specific heat and thermal expansion of barium-strontium titanate ceramics. S. SAWADA AND S. NOMURA. *J. Phys. Soc. Japan*, **5**, 231–2 (*July–Aug.*, 1950).

The specific heat and coefficient of expansion of 90% $BaTiO_3$–10% $SrTiO_3$ ceramic material are measured, and the values at the Curie temperature compared with the values obtained for pure $BaTiO_3$ material. The specific heat is almost equal to that of pure $BaTiO_3$, but the coefficient of expansion is greater. E. RUSHTON

536.44

1798. Introduction to the symposium on critical phenomena. General consideration of critical phenomena. O. K. RICE. *J. Phys. Coll. Chem.*, **54**, 1293–305 (*Dec.*, 1950).

Liquid-vapour coexistence curves and the isotherms of one-component systems are discussed; also the coexistence or mutual solubility curves in binary liquid systems, and the corresponding isotherms. Relevant experimental data are considered. A brief review is given of the association theory of condensation, in which condensation is considered as a limiting case of the formation of clusters of molecules in the vapour phase. The application to critical phenomena is indicated, and it is shown that these considerations lead one to anticipate an isotherm (pressure *v.* volume in a one-component system) which has a finite horizontal portion at the critical temperature, with isotherms above the critical temperature having everywhere a finite slope. The importance of a correct evaluation of the free volume in which a cluster can move and the significance of the surface tension of large clusters are particularly stressed. The effect of an impurity (small amount of a third component) on the critical phenomena in a binary liquid is considered. It is shown that the effect of the third component on the interfacial tension of a two-phase system can be important. A.

536.44

1799. Solubility measurements in the critical temperature region. I. D. ATACK AND W. G. SCHNEIDER. *J. Phys. Coll. Chem.*, **54**, 1323–36 (*Dec.*, 1950).

A review of experimental work pertaining to the nature of the liquid-vapour phase transition at the critical temperature. The significance of the critical "dispersion" temperature and the importance of attaining equilibrium states are discussed. A method for determining solubilities in the critical temperature region using a tracer technique is described, and measurements are given for the system 1-chloro-4-iodobenzene–ethane. The rate of equilibration in slightly supercritical systems is shown to be very slow in the absence of stirring, yet comparatively rapid with intimate stirring. Evidence is presented which indicates the possibility of molecular clustering in the slightly supercritical region. A.

536.44

1800. The application of kinetic theory to the critical curve for aqueous solutions of 1-1 electrolytes. C. H. SECOY. *J. Phys. Coll. Chem.*, **54**, 1337–46 (*Dec.*, 1950).

An equation which gives the relation of critical temperature of aqueous solutions of 1-1 electrolytes to the composition of the solution has been developed by the application of kinetic theory. With the aid of assumptions concerning the types of particles present and their effective radii, this equation has

been shown to describe the available data for solutions of NaCl, KCl, KBr and KI. The success in applying the equation does not substantiate the assumptions made but merely demonstrates the applicability of an equation based on kinetic theory. The significance of the numerical values obtained for the equation constants has been discussed. A.

536.48

1801. Film transfer in helium II: I. The thermo-mechanical effect. J. G. DAUNT AND K. MENDELSSOHN. *Proc. Phys. Soc., Lond., A*, **63**, 1305–12 (*Dec.*, 1950).

The existence of a thermo-mechanical pressure difference has been established with the transfer film instead of a capillary connecting the two volumes of liquid He II. It is shown that under these circumstances reversible conditions are closely approximated since return flow of heat or liquid through the film is negligible. The speed with which a thermo-mechanical pressure difference can be established is limited by the same critical transfer rate as that determining film transport under gravitation. A.

536.48

1802. Film transfer in helium II: II. Influence of geometrical form and temperature gradient. J. B. BROWN AND K. MENDELSSOHN. *Proc. Phys. Soc., Lond., A*, **63**, 1312–18 (*Dec.*, 1950).

Experiments have been carried out in order to investigate a possible dependence of the film transfer in liquid He II on the geometrical conditions of the measuring arrangement or on a temperature gradient along the film. Using transfer vessels of different shape, no variation in the rate of transfer could be detected. Equally no change from the ordinary rate of flow could be found under temperature differences up to $3{\cdot}5\times10^{-2}$ deg. A.

536.48

1803. Film transfer in helium II: III. Influence of radiation and impurities. R. BOWERS AND K. MENDELSSOHN. *Proc. Phys. Soc., Lond., A*, **63**, 1318–27 (*Dec.*, 1950).

In contradiction to the results of de Haas and van den Berg, the complete exclusion of thermal radiation has not been found to increase the transfer rate beyond the normal value. It was observed, however, that contamination of the transfer surface with condensed gases will cause a greatly increased film flow. The effect of impurities on the transfer has been studied in detail and the conclusion has been reached that the high and variable transfer values recently reported by some observers are to be ascribed to this cause. The bearing of the effect on cryogenic technique is discussed. A.

536.48

1804. Film transfer in helium II: IV. The transfer rate on glass and metals. K. MENDELSSOHN AND G. K. WHITE. *Proc. Phys. Soc., Lond., A*, **63**, 1328–36 (*Dec.*, 1950).

The rate of transfer R has been measured as a function of temperature along surfaces of glass, platinum and nickel. While the (R, T) curves have all approximately the same shape, the absolute values of R on metals were found to be much higher than on glass. The effects of polishing and degassing of the transfer surfaces have been studied. Possible explanations for the observed effects are discussed. A.

536.48

1805. The vapor pressure, critical point, heat of vaporization, and entropy of liquid He^3. B. M. ABRAHAM, D. W. OSBORNE AND B. WEINSTOCK. *Phys. Rev.*, **80**, 366–71 (*Nov.* 1, 1950).

The vapour pressure of pure liquid He^3 was measured from 1·025° to 3·35°K, and the data are represented accurately by the equation $\log_{10} p_{mm} = -0{\cdot}97796/T + 2{\cdot}5\log_{10} T + 0{\cdot}000302T^3 + 1{\cdot}91594$. The normal boiling point is $3{\cdot}195 \pm 0{\cdot}001$°K. The critical temperature and pressure were determined to be $3{\cdot}35 \pm 0{\cdot}02$°K and 890 ± 20 mm Hg, respectively. The calculated heat of vaporization has a maximum value of $11{\cdot}4 \pm 0{\cdot}4$ cal mole^{-1} at 2·1°K, and the extrapolated value at 0°K is 4·47 cal mole^{-1}. The calculated entropy of liquid He^3, excluding the nuclear spin entropy, is $0{\cdot}75 \pm 0{\cdot}1$ cal deg^{-1} mole^{-1} at 1°K, and the extrapolated value at 0°K is $0{\cdot}42 \pm 0{\cdot}1$ cal deg^{-1} mole^{-1}. This extrapolated value of the entropy suggests that below 1°K there is either a triple point or an anomaly in the heat capacity. A.

536.48

1806. The viscosity of liquid helium between 2 and 5°K. R. BOWERS AND K. MENDELSSOHN. *Proc. Roy. Soc. A*, **204**, 366–74 (*Dec.* 22, 1950).

This has been measured with a flow method. The coefficient of viscosity decreases with decreasing temperature over the whole range. A particularly interesting feature is a sharp drop in the viscosity above the λ-point which coincides with an anomalous fall in the entropy in the same temperature interval. Possible explanations of this phenomenon have been discussed. A.

536.48 : 530.145

Quantum mechanics and low-temperature research. *See Abstr.* 1599

536.48 : 534.21

1807. On the theory of the propagation of sound in He II. R. KRONIG AND A. THELLUNG. *Physica*, **16**, 678–90 (*Sept.*, 1950).

The theory of the propagation, and in particular of the attenuation, of 1st and 2nd sound in He II is considered in greater detail than has been done hitherto, using the 2-fluid model as a basis. In addition to the waves of 1st and 2nd sound there can occur near material boundaries two other kinds of waves: one which has an almost purely imaginary wave number and hence is aperiodic in space with exponential damping, reducing it to small proportions over a distance of 10^{-7} m or less; the other of the character of the viscosity waves, also encountered in ordinary fluids and strongly damped over the distance of one wavelength. All 4 types of waves can most conveniently be derived from velocity potentials and are in general necessary to fulfil the boundary conditions. The behaviour of these waves when the temperature passes the λ-point or approaches absolute zero is investigated. The experimental evidence is discussed in the light of the results obtained. A.

536.48 : 536.5

1808. Thermometrical research in the region of low temperatures. P. G. STRELKOV. *Izv. Akad. Nauk, SSSR, Ser. Fiz.*, **14** (*No.* 1) 115–21 (1950) *In Russian.*

Review of research carried out during the last decade by the author and co-workers. F. LACHMAN

536.48 : 536.7

1809. Non-equilibrium thermodynamics and liquid helium II. S. R. DE GROOT, L. JANSEN AND P. MAZUR. *Physica*, **16**, 691–708 (*Sept.*, 1950).

The thermodynamics of irreversible processes, based on the Onsager reciprocal relations, is applied to a system consisting of a mixture of two substances, of which one can go over into the other. The mixture is enclosed in two communicating reservoirs at different temperatures T and $T + \Delta T$. For the stationary state of the first order with fixed ΔT the corresponding pressure difference ΔP is calculated. This gives the thermomolecular pressure effect $\Delta P/\Delta T = -Q^*/vT = (h - U^*)/vT$, where h and v are the mean specific enthalpy and volume. This equation shows the connection with the mechanocaloric effect Q^*, since application of the Onsager relations shows that Q^* is the "heat of transfer." Similarly U^* is the "energy of transfer." The influence of ΔT on the relative separation (thermal effusion) and the "chemical affinity" of the two components is also calculated. The results can be applied to liquid helium II, considered in the two-fluid theory as a mixture of "normal" (1) and "superfluid" (2) atoms, capable of the "chemical reaction" $1 \rightleftarrows 2$. When it is supposed that chemical equilibrium is immediately established and that only superfluid atoms can pass through a sufficiently narrow capillary, the above-mentioned equation leads to Gorter's formula $v\Delta P/\Delta T = x_1 \delta s/\delta x_1$, where x_1 is the fraction of normal atoms and s the mean specific entropy of the mixture. A.

536.511 : 536.74

1810. On the theory of a gas thermometer giving the thermodynamic temperature without corrections for imperfections of the gas. J. P.-E. DUCLAUX. *C.R. Acad. Sci., Paris*, **231**, 1040–2 (*Nov.* 13, 1950) *In French.*

For moderate pressures as used in gas thermometers only the correction term containing the first virial coefficient is of importance. If the law of corresponding states were valid the virial coefficient, B, would be the product of a characteristic constant and a universal function of the reduced temperature; this is not confirmed experimentally. It is claimed that for many gases B is the sum of two terms, a characteristic constant and the product of another characteristic constant and a universal function of T. The value of B for any gas is therefore a linear function of that for any other gas. The values for A have been calculated in this way from those for He and are in satisfactory agreement with those from experiment. The linear dependence of the virial coefficients leads to an equation for the difference in pressures in two gas thermometers with different gases, as a linear function of the absolute temperature which contains no variable terms to correct for gas imperfections.

F. E. HOARE

536.531 : 536.48

1811. A resistance-temperature relation for low temperature thermometry. H. J. HOGE. Note in *Rev. Sci. Instrum.*, **21**, 815–16 (*Sept.*, 1950).

536.582

1812. Thermostatic temperature control of an accuracy of $\pm 0{\cdot}0005$°C obtained by simple means. P. A. FINOGENOV. *J. Tech. Phys., USSR*, **20**, 480–2 (*April*, 1950) *In Russian.*

This high precision of thermostatic control required, e.g., for dilatometry, is obtained by a particularly careful design of the thermostat. It consists of the usual double-walled thermostatic vessel with a special inset vessel containing the liquid to be kept at constant temperature, dilatometer and Beckmann thermometer. The outer thermostat contains the controlling element, a highly sensitive mercury–toluene contact thermometer communicating with a system of capillaries acting as a syphon, and with a fine control in the form of a fused-in Pt-wire; also the necessary heater element and cooling coil and stirrer. The Beckmann thermometer is read by microscope.

B. F. KRAUS

THERMODYNAMICS 536.7/.8

536.71 : 530.162

The quantum-mechanical equation of state. *See Abstr.* 1629

536.77

1813. Thermodynamic equilibrium. G. A. ELLIOTT. Letter in *Nature, Lond.*, **166**, 962 (*Dec.* 2, 1950).

Correction of sign in previous letter [Abstr. 6525 (1950)] and a further discussion of equilibrium conditions in terms of chemical potentials. F. E. HOARE

ELECTRICITY 537

537.081.1 : 541.12

1814. A new method for determining the value of the Faraday. D. N. CRAIG AND J. I. HOFFMAN. Letter in *Phys. Rev.*, **80**, 487 (*Nov.* 1, 1950).

THEORY . ELECTRONS 537.1

537.1 : 530.12

1815. On the origin of positive and negative electricity. A. GIAO. *Portugal. Math.*, **8** (*No.* 4) 143–52 (1949).

Space-time is regarded as a hypersurface V_4 in an enveloping Euclidean 5-space E_5, electromagnetic properties being determined by the external metric of V_4 in E_5. A deformation in V_4 can be covered by two external metrics corresponding to the two directions of the normal vectors to V_4. The two possibilities lead to electric distributions of equa-

magnitude but opposite in sign, the corresponding material energy momentum tensor being the same in the two cases in agreement with the fact that mass, unlike electric charge, is essentially positive.

R. A. NEWING

ELECTROSTATICS . DIELECTRICS 537.2

537.226.2

1816. Time relation in processes of dielectric polarization for barium titanate and Seignette salt. N. S. NOVOSILTSEV. *J. Tech. Phys., USSR*, **20**, 809–13 (*July*, 1950) *In Russian.*

Discharges of capacitors with specimens of the tested materials as dielectric through active resistances were recorded by an oscillograph specially designed to obtain a continuous curve. Its advantage over Gödeke's complicated valve-circuit used for the same purpose was that vitiating influences of the circuit parameters were eliminated. Above and below the Curie point the discharge curves of the Ba titanate capacitor are strictly of the form $V_1 = V_0 \exp(-1/RC)$; this means that the polarizing mechanism of Ba titanate works very rapidly, the dielectric constant remaining constant throughout the discharge process, even at very high frequencies. A second retarding mechanism of polarization becomes active only high above Curie point. Tan δ is slightly reduced near the Curie point, owing to capacitance rise in this region. Seignette salt maintains ε constant only outside the range of spontaneous polarization and its losses are thus negligible. Below the Curie point its dielectric constant falls owing to slow polarization mechanism, which also explains the drop of ε with increasing frequency. B. F. KRAUS

537.226.2

1817. Note on the dielectric constant of solutions of polystyrenes and polyisobutylenes in toluene. A. VOET AND L. R. SURIANI. Note in *J. Phys. Coll. Chem.*, **54**, 1070–2 (*Oct.*, 1950).

537.226.2 : 536.48

1818. Erratum: A ferroelectric Curie point in $KTaO_3$ at very low temperatures. J. K. HULM, B. T. MATTHIAS AND E. A. LONG. Letter in *Phys. Rev.*, **80**, 490 (*Nov.* 1, 1950).—See Abstr. 294 (1951).

537.226.2 : 539.133

1819. Dielectric relaxation in glycerine. D. W. DAVIDSON AND R. H. COLE. Letter in *J. Chem. Phys.*, **18**, 1417 (*Oct.*, 1950).

537.226.3

1820. Dielectric relaxation of alcohol–heptane mixtures. C. S. E. PHILLIPS. Letter in *Nature, Lond.*, **166**, 866–7 (*Nov.* 18, 1950).

537.226.8

1821. On the thermo-dielectric effect. J. COSTA RIBEIRO. *An. Acad. Brasil. Cienc.*, **22** (*No.* 3) 325–48 (1950).

If the dielectric in a capacitor is partly solid and partly liquid an electric current is observed when solidification or melting occurs at the boundary between the phases, provided that one of the plates is in contact exclusively with the solid and the other with the liquid phase. The direction and magnitude of the current are related to the direction and velocity of the phase change, respectively. For a particular material the total charge developed between two states of equilibrium of the solid-liquid system is proportional to the mass of dielectric which changes state. The effect is small, e.g. a charge of 3×10^{-8} C is generated when 10 g of naphthalene are melted; the e.m.f. developed is not stated. A current is developed when sublimation occurs, but is not found when transformation occurs between liquid and gaseous phases. The existence of an electric double layer at the interface between the phases is postulated to explain the effect. J. H. MASON

537.228.1

1822. On the noise of Rochelle salt. II. Barkhausen effect. S. KOJIMA AND K. KATO. Note in *J. Phys. Soc. Japan*, **5**, 379–80 (*Sept.–Oct.*, 1950).

From observations of the number of pulses, the size distribution of the pulses, the equivalent volume of the Barkhausen region and the propagation velocity of polarization are evaluated. The Barkhausen effect decreases with increasing temperature [Abstr. 5816 (1950)]. E. RUSHTON

537.228.1

1823. Piezoelectric constants of alpha- and beta-quartz at various temperatures. R. K. COOK AND P. G. WEISSLER. *Phys. Rev.*, **80**, 712–16 (*Nov.* 15, 1950).

The adiabatic piezoelectric constants d_{11} and d_{14} of alpha-quartz have been measured between room temperature and 571·5°C. At the latter temperature, d_{11} is about one-half of its room temperature value, whereas d_{14} has increased by a factor of almost three. At 573°C (the inversion temperature) the crystal structure changes to that of beta-quartz, and d_{11} vanishes. The constant d_{14} for beta-quartz has been measured between 584°C and 626°C. d_{14} appears to be substantially constant over this short range of temperature, and differs from d_{14} for alpha-quartz at about 570°C by only a few per cent. The piezoelectric constants were deduced from measurements (with a Q-meter technique) of the equivalent circuits of long thin bars driven electrically at frequencies near resonance. A.

537.228.1 : 548.0

1824. Increase in Q-value and reduction of aging of quartz crystal blanks. A. C. PRICHARD, M. A. A. DRUESNE AND D. G. MCCAA. Note in *Acta Cryst.*, **3**, 73 (*Jan.*, 1950).

ELECTRIC CONDUCTION . CURRENTS 537.3

537.3 : 537.533 : 538.551.25 : 621.38 : 621.396.611.1

1825. The noise-spectrum cut-off of oscillating circuits. W. BÖER. *Ann. Phys., Lpz.*, **8** (*No.* 1) 87–92 (1950) *In German.*

The relation of noise to the bandwidth of a subsequent amplifier shows that the noise voltage decreases with increased damping in the circuit and increases

with increasing relative bandwidth. It is assumed that: (i) the bandwidth is small compared with the resonance frequency, and (ii) $R^2 \ll L/C$. It is not always best to employ input circuits with minimum damping. For specific problems the optimum ratio L/C is discussed. J. JACOBS

537.311.1

1826. The electron and electrical conduction in solids. J. MALSCH. *Elektron*, **4**, 348–55 (*Oct.–Nov.*, 1950) *In German.*

The analogy between kinetic theory of gaseous molecules and free electrons in solids is discussed and the band theory briefly outlined. C. A. HOGARTH

537.311.31 : 538.632 : 539.234

1827. Hall coefficient and resistivity of thin films of antimony prepared by distillation. W. F. LEVERTON AND A. J. DEKKER. *Phys. Rev.*, **80**, 732–6 (*Nov.* 15, 1950).

An a.c. method is described for measuring the Hall coefficient. An apparatus for the preparation of very pure evaporated metal films is also described. This apparatus eliminates such sources of contamination as hot filaments. The effect of annealing on both Hall coefficient and resistivity of evaporated films of Sb is examined. A tentative explanation is presented for the observed increase in the Hall coefficient and decrease in the resistivity. It is based on the assumption of partial recombination of electrons and holes. The Hall coefficient of unannealed evaporated films is $0{\cdot}215_9$ c.g.s.m., and of annealed films is $0{\cdot}244_1$ c.g.s.m. with an accuracy of 1%. The resistivity of the annealed films is 1·28 times that of bulk Sb. A.

537.311.32

1828. D.C. resistance of barium titanate and its solid solutions ceramics. S. NOMURA AND S. SAWADA. *J. Phys. Soc. Japan*, **5**, 227–30 (*July–Aug.*, 1950).

The d.c. resistivity, ρ, of $BaTiO_3$ and also of 90% $BaTiO_3$–10% $SrTiO_3$ and 90% $BaTiO_3$–10% $PbTiO_3$ mixtures is found to obey a relation of the form: $\rho = Ae^{\phi/KT}$, where A and K are constants, T is the absolute temperature and ϕ is the activation energy. The value of ϕ is greater at temperatures above the Curie temperature than at temperatures below it.

E. RUSHTON

537.311.32 : 538.63

1829. On the electrical conductivity of magnetite. H. WATANABE AND N. TSUYA. *J. Phys. Soc. Japan*, **5**, 281–3 (*July–Aug.*, 1950).

The temperature-dependence of the electrical resistance of single crystal specimens of magnetite was investigated and a sudden change in the temperature coefficient observed at − 150°C, close to the magnetic transformation point. The change of resistance in a magnetic field was found to be small both above and below the transformation point, the value of $|\Delta R/R|$ being <1% in a field of 1 400 oersted.

E. P. WOHLFARTH

537.311.33

1830. On the electric formation of the selenium rectifier. M. TOMURA. *J. Phys. Soc. Japan*, **5**, 222–7 (*July–Aug.*, 1950).

The manufacturing process of a practical Se rectifier is described and the temperature-dependence of rectification before and after the electrical forming proce is measured. It is concluded that the magnitude the current may be explained by Mott's (1939) theo plus a current due to tunnel effect. The formi process reduces tunnelling of the barrier. The no uniform structure of the barrier layer is investigat by using a vacuum-evaporated thin Cd film as count electrode. When a current flows, coloured spo appear where high currents pass, and where tunn effects are considerable. From a study of the V curves it is deduced that the actual constitution of t barrier layer is unaffected by forming; only the "thi regions are "healed" by local Joule heating and me ing of the Se, and its probable conversion to a insulating modification. C. A. HOGART

537.311.3

1831. On the characteristics of the selenium rectifi at low temperatures and the electric formation. M TOMURA. *J. Phys. Soc. Japan*, **5**, 349–53 (*Sept.–Oc* 1950).

Voltage-current characteristics in both directio for short durations of current flow were taken for S rectifiers at temperatures from + 70° to − 180° Currents at higher reverse voltages show unusu characteristics at low temperatures. Curren measured at low temperatures are due to tunnellin and those in the reverse direction at high voltages field emission. The previous idea of a local spreadi resistance is observed in practice. The author's pr vious remarks on "patch" effects in disc rectifiers a further developed [see Abstr. 1830 (1951)].

C. A. HOGART

537.311.3

1832. *P–N* junctions prepared by impurity diffusio R. N. HALL AND W. C. DUNLAP. Letter in *Phy Rev.*, **80**, 467–8 (*Nov.* 1, 1950).

537.311.33 : 537.312.5 : 621.383 : 621.315.5

1833. Investigation of the kinetics of photoconduc tivity of semiconductors by a compensation metho V. E. LASHKAREV. *Izv. Akad. Nauk, SSSR, Ser. Fiz* **14** (*No.* 2) 199–211 (1950) *In Russian.*

An apparatus is described whereby τ, the natur response time of a semiconductor, and α, the increa in photocurrent/unit time/unit light flow, can b determined. The apparatus is operated and co structed as follows. Sinusoidally modulated lig from a modulator previously described [Abstr. 19 (1949)] falls on the two equal sides of a right-angle prism whereby it is split into two equal parts. O part falls on to the semiconductor, which is in seri in a circuit containing also a battery and a resistance The other half of the light falls on to a vac. photoc which is in series in a circuit containing a battery and variable resistance R shunted by a variable capacitan C. Since the photoelectric process in the sem conductor requires a definite time for its develo ment, the photocurrent will be out of phase with t light and the voltage v across r will be also out phase to the same extent. The voltage V across may be regarded as being in phase with the light, b by varying R and C it is possible to equate V and in amplitude and phase; this is indicated by means a cathode-ray oscillograph connected to the tw circuits via an amplifier. The apparatus can b

modified for measurements with constant illumination. The theory of the method is developed and used experimentally for investigating the kinetics of photoconductivity of 4 samples of PbS for a frequency range 0·4–15 kc/s. Different samples of PbS show a very great variation in natural response time, e.g. 18×10^{-5}–$2\cdot8\times10^{-5}$ sec, indicating the non-linearity of PbS photoresistance. Results in this non-linear region are discussed. W. HUGHES

537.311.33 : 548.73

1834. X-ray analysis on selenium layers of selenium rectifiers. J. YAMAGUCHI AND S. KATAYAMA. Letter in *J. Phys. Soc. Japan*, **5**, 385–6 (*Sept.–Oct.*, 1950).

The orientation of Se crystallites in Se rectifiers is studied by an X-ray diffraction method. The Se layer was set at angles from 5° to 45° from the direction of incident beam and diffracted patterns were recorded on cylindrical films. It is concluded that if the fibre axis is oriented normally to the base plate [112] is the fibre axis. Rectifying and resistance characteristics do not depend on the orientation of the crystallites which have a random orientation when the Se is pressed below 30 kg/cm² and preferred orientation when compressed above this value.

C. A. HOGARTH

537.311.33 : 548.73

1835. On cadmium selenide of selenium rectifiers. J. YAMAGUCHI AND S. KATAYAMA. Letter in *J. Phys. Soc. Japan*, **5**, 386–7 (*Sept.–Oct.*, 1950).

By X-ray methods it is found that a layer of hexagonal CdSe approximately 10^{-4} cm thick is formed on the surface of Se rectifiers by sputtering with Cd. The normal forming processes do not change the form of the CdSe although later heat treatments may convert it to a cubic form. CdSe prepared by a "paste" method is amorphous but forms mixed cubic and hexagonal crystallites on heating to 200°C.

C. A. HOGARTH

537.311.33 : 621.3.014.2 : 621.314.63

1836. Inverse current in high-voltage germanium diodes. P. AIGRAIN. *C.R. Acad. Sci., Paris*, **231**, 1047–8 (*Nov.* 13, 1950) *In French.*

The increase in inverse current at high voltages is explained by considering that the surface conductivity (due to positive holes) is modulated by the intense field in the immediate vicinity of the contact, modified by local irregularities, regions where there is no rectification, etc. A. H. W. BECK

537.311.37.08

1837. Method of measuring the conductivity of dielectrics. I. M. IMYANITOV. *J. Tech. Phys., USSR*, **20**, 805–9 (*July*, 1950) *In Russian.*

A novel method of measuring the conductivity of air, using the principle of measuring the leakage current from a charged capacitor. The plate capacitor used was subdivided into one part representing a closed box and another, open, part. The measurement is a relative one, and the instrument used a loop galvanometer (oscillograph), permitting of continuously recording variations of conductivity within intervals of about $_2\frac{1}{0}{}_0$ sec. B. F. KRAUS

537.311.4

1838. Dependence of the contact resistance between metal and semi-conductor on the contact p.d. V. I. LYASHENKO AND A. M. PAVLENKO. *J. Tech. Phys., USSR*, **20**, 854–7 (*July*, 1950).

When the contact resistance between Cu_2O and pressed-on metal electrodes was investigated, approximate agreement with Davidenkov's law was only found where the contact p.d.'s between metal and semi-conductor were small; at greater p.d.'s the discrepancies were found. This prompted the authors to carry out specially careful investigations of the true relation with foils of different metals on Pt surface electrodes, and to exclude effects of surface configuration by testing each particular metal in the form of a foil (always under exactly the same pressure) in three surface modifications: surface bright, not etched; surface etched with HNO_3; polished with fine glass paper. Results are given in graphed form.

B. F. KRAUS

537.312.5

1839. Fundamental investigation of photoconductivity. I. Definition of the problem and the method of research. S. M. RYVKIN. *J. Exp. Theor. Phys., USSR*, **20**, 139–51 (*Feb.*, 1950) *In Russian.*

Photoconductivity can be presented as a product of parameters which, in the simplest case, are independent from one another. Full interpretation of the results of photoconductivity investigations is only possible when each of these parameters is quantitatively studied. Methods of eliminating the interfering phenomena are discussed, as well as a method of investigating photoconductivity by using rectangular impulses of light; the latter method allows study almost simultaneously of the stationary photoconductivity, the period of life of the photocurrent carriers, and the quantum yield of the internal photoeffect in semiconductors. F. LACHMAN

537.312.5

1840. Fundamental investigation of photoconductivity. II. Photoconductivity of cuprous oxide. V. P. ZHUZE AND S. M. RYVKIN. *J. Exp. Theor. Phys., USSR.*, **20**, 152–65 (*Feb.*, 1950) *In Russian.*

Temperature variation has been investigated of: stationary photoconductivity, life period of the photocurrent carriers, and the quantum yield of the internal photoeffect of Cu_2O. It has been found that there exists an exponential law between the quantum yield β (also life period τ) and the reciprocal temperature; a relationship has also been found between the dark conductivity σ and photoconductivity. A theoretical explanation of these relationships has been suggested, based on the assumption that the photoconductivity of Cu_2O is due to "admixtures."

F. LACHMAN

537.312.5

1841. The ultimate limits of sensitivity of lead sulfide and telluride photo-conductive detectors. T. S. MOSS. *J. Opt. Soc. Amer.*, **40**, 603–7 (*Sept.*, 1950).

Calculations are carried out for the theoretical limits of sensitivity of Pb salt photo-conductive cells, on the basis of fluctuations in the room temperature radiation quanta falling on the cell. The results show a marked dependence on the temperature of the layer, and on

the form of the spectral sensitivity curve. Using cooled detectors exposed to room temperature radiation, it should be possible to detect 8×10^{-14} W at $2\cdot9\,\mu$ with PbS, and 9×10^{-13} W at $5\cdot0\,\mu$ with PbTe. A.

537.312.5

1842. The surface photoelectric effect. M. J. BUCKINGHAM. *Phys. Rev.*, **80**, 704–8 (*Nov.* 15, 1950).

Theoretical expressions describing the photoelectric emission from a metal surface are derived, taking account of the dependence, established by Bardeen, of the effective surface barrier on the momentum of the impinging electron, due to exchange and correlation forces in the interior. This generalization reduces by a significant factor the magnitude of the theoretical expression for the absolute photoelectric yield. The shapes of the energy and spectral distributions of emitted photoelectrons are essentially unchanged, so that certain well-known disagreements between theoretical and observed distributions near the threshold remain unexplained. The influence of the transmission coefficient of the surface potential barrier on the photoelectric properties of a metal is discussed and an experiment is proposed for determining directly the variation with energy of the transmission coefficient, thus leading to information concerning the shape of the barrier. A.

537.312.5

1843. Photoconductivity in magnesium antimonide layers. T. S. MOSS. *Proc. Phys. Soc., Lond. B*, **63**, 982–9 (*Dec.*, 1950).

Layers of Mg_3Sb_2 evaporated *in vacuo* are found to exhibit semiconducting properties, although both constituents are normally metals. Under suitable conditions the layers are photosensitive. Measurements have been carried out on the spectral distribution of sensitivity, and show bands with long wavelength edges at $1\cdot5\,\mu$, $2\cdot6\,\mu$ and $3\cdot5\,\mu$. The former is identified with intrinsic conductivity, and the two latter with impurity levels. Activation energies found from resistance-temperature measurements are very similar to the optical activation energies corresponding to the above wavelengths. A.

537.312.5 : 548.0

1844. On the change with time of photoelectric currents in alkali halide crystals. O. VON GERICKE. *Nachr. Wiss. Göttingen, Math.-phys. Kl.*, IIa (*No.* 4) 1–8 (1950) *In German.*

Curves of the development of the photoelectric current with time in NaCl and KCl crystals were measured by means of a cathode-ray tube with an amplifier with a resolving power of approximately 5×10^{-6} sec. In NaCl at room temperature, the current builds up within a period shorter than the resolving power. For KCl, which gives much smaller currents, the current builds up within less than 2×10^{-5} sec. An inertia-less current to within 10^{-4} sec could be observed in KCl up to a temperature of 20°C. W. F. BERG

537.312.5 : 548.0

1845. Photoelectric changes induced in SrO and BaO by ultraviolet irradiation. J. E. DICKEY AND E. A. TAFT. Letter in *Phys. Rev.*, **80**, 308 (*Oct.* 15, 1950).

537.312.62

1846. Wave functions for superconducting electrons. J. BARDEEN. *Phys. Rev.*, **80**, 567–74 (*Nov.* 15, 1950).

The observed variation of the transition temperature of Hg with isotopic mass is evidence that the superconducting state arises from interaction of electrons with lattice vibrations. The interaction term which gives scattering of electrons at high temperatures contributes at low temperatures a term to the energy of the system of electrons plus normal modes. Fröhlich has calculated the interaction energy at $T = 0°\text{K}$ by 2nd-order perturbation theory. The energy is calculated here by taking wave functions of superconducting electrons, which have energies near the Fermi surface, as linear combinations of Bloch functions whose coefficients are functions of coordinates of the normal modes. In an equivalent approximation, Fröhlich's expression for the interaction energy is obtained. When the energy is calculated directly rather than by perturbation theory, modified expressions are obtained for the energy and distribution of electrons in the superconducting state. The criterion for superconductivity is $\hbar/\tau > \sim 2\pi\kappa T$ where τ is the relaxation time for electrons at some high temperature T where τT is constant. It is shown that superconducting electrons have small effective mass. A.

537.312.62

1847. Theory of superconductivity. L. TISZA. *Phys. Rev.*, **80**, 717–26 (*Nov.* 15, 1950).

A quantum-mechanical model has been developed exhibiting the characteristic properties of superconductors. Localized "atomic" wave functions are used to construct many-electron wave functions obeying the exclusion principle and corresponding to definite electronic localization (ϕ-functions). The crystal translations will take these over into a set of, say, ω, equivalent ϕ-functions. Quantum resonance of these provides a zero-order wave function with the correct symmetry properties (Ψ-functions). The ϕ-functions of small ω have a high translational symmetry and are referred to as "electron-lattices." The model has superconducting properties if its lowest state is described by a ψ-function obtained through the resonance of at least three resonating electron lattices, and if this state is somewhat depressed below the continuum of high ω-states. The latter can also be described in the standard band formalism. In the absence of external fields the lowest state is without a current. If the transition from ϕ- to ψ-functions is carried out in the presence of a magnetic field, one automatically obtains a current "induced" by the field, and connected with it by the well-known London relation. The present method is not adequate to prove that the conditions stated are actually satisfied in superconductors. Nevertheless, qualitative quantum-chemical arguments make it appear plausible that these conditions are satisfied in the regions of the periodic table where the actual superconductors are located. Conversely, if the theory is accepted, a rather detailed insight is gained into the quantum-chemical properties of superconductors. The recent experimental and theoretical work on the isotope effect is being discussed. A.

537.312.62

1848. A note on Tisza's theory of superconductivity. J. M. LUTTINGER. *Phys. Rev.*, **80**, 727–9 (*Nov.* 15, 1950).

The equation of F. London connecting the electric field and the current in a superconductor is derived on the basis of Tisza's theory of superconductivity. A.

537.312.62

1849. The superconductivity of columbium. D. B. COOK, M. W. ZEMANSKY AND H. A. BOORSE. *Phys. Rev.*, **80**, 737–43 (*Nov.* 15, 1950).

Isothermal critical magnetic field curves and zero field transitions for several annealed specimens of Nb (Cb) have been measured by an a.c. mutual inductance method, at temperatures from 5·1°K to the zero field transition temperature. The $H - T$ curve was found to fit the usual parabolic relationship $H = H_0(1 - T^2/T_0^2)$ with $H_0 = 8\,250$ oersteds and $T_0 = 8{\cdot}65$°K. The initial slope of the curve was 1 910 oersteds/deg. The electronic specific heat in the normal state calculated from the thermodynamic equations is $0{\cdot}0375T$ and the approximate Debye characteristic temperature in the superconducting state, 67°K. Results on a different grade of Nb with a Ta impurity of 0·4%, according to neutron scattering measurements, were in agreement with the data obtained from Nb of 0·2% maximum Ta impurity. A.

537.312.62

1850. Superconductivity of tin isotopes. W. D. ALLEN, R. H. DAWTON, J. M. LOCK, A. B. PIPPARD AND D. SHOENBERG. Letter in *Nature, Lond.*, **166**, 1071 (*Dec.* 23, 1950).

Superconducting transition temperatures (T_c) and critical magnetic fields (H_c) of Sn isotopes 116, 120, 124 have been measured magnetically and the relation $T_c \propto M^{-\frac{1}{2}}$ confirmed. The $H_c - T$ relation could be expressed as $H_c = T_c f(T/T_c)$, where f is the same function for all 3 isotopes: the values of $H_c(0°K)/T_c$ and of (dH_c/dT) at T_c were 81·5 and 142 gauss/°K respectively for all 3 isotopes. D. SHOENBERG

537.312.62

1851. Superconductivity of tin isotopes. W. D. ALLEN, R. H. DAWTON, M. BÄR, K. MENDELSSOHN AND J. L. OLSEN. Letter in *Nature, Lond.*, **166**, 1071–2 (*Dec.* 23, 1950).

The relation $T_c \propto M^{-\frac{1}{2}}$ (see previous Abstr.) was confirmed both magnetically and by resistance measurements. Resistance measurements of H_c gave values of $H_c(0°K)/T_c$ of 81·8, 80·5 and 79·9, and of dH_c/dT_c at T_c of 152, 157 and 154 gauss/°K for the isotopes 116, 120 and 124. The figures for a similar specimen of natural Sn were 81·9 and 163.

D. SHOENBERG

537.312.62 : 536.63

1852. On the deviations between theoretical and experimental values of the specific heat of superconductors. K. F. NIESSEN. *Physica*, **16**, 709–18 (*Sept.*, 1950).

The deviations are explained qualitatively by the combination of two effects, the more important of which is based on the assumption that the thickness of Heisenberg's superconducting layer, covering part of the Fermi surface, does not fall abruptly to zero at the boundary of the layer. The other effect, which was more obvious but appeared to be of less importance, comes into play when the thickness of the superconducting layer decreases with increasing temperature. A.

537.312.8

1853. The influence of a transverse magnetic field on the conductivity of thin metallic films. E. H. SONDHEIMER. *Phys. Rev.*, **80**, 401–6 (*Nov.* 1, 1950).

The influence of a transverse magnetic field on the conduction properties of thin metallic films, of thickness comparable with the free path of the conduction electrons, is investigated. It is shown that, owing to scattering of electrons at the boundaries of the film, the Hall coefficient is increased, and the electrical resistance oscillates with the strength of the applied magnetic field. A.

537.32 : 538.63 : 538.652

1854. The change in thermal e.m.f. produced by magnetization of a single crystal of iron. Z. FUNATOGAWA. *J. Phys. Soc. Japan*, **5**, 311–16 (*Sept.–Oct.*, 1950).

Measurements were made of the thermoelectric power of Fe single crystals against Cu as the magnetization increases from remanence to saturation. A correspondence between magnetostriction and magneto-thermoelectricity was established. Representative values are $\lambda_{100} = 25{\cdot}9 \times 10^{-6}$, $\lambda_{111} = -19{\cdot}1 \times 10^{-6}$; $E_{100} = 7{\cdot}0 \times 10^{-8}$, $E_{111} = -1{\cdot}3 \times 10^{-8}$ V deg^{-1}. The mechanism of the effect is briefly discussed. E. P. WOHLFARTH

537.323 : 536.4

1855. Effects of the transformation process on the thermo-electric power of the superlattice alloy Cu_3Au. T. SATO. *J. Phys. Soc. Japan*, **5**, 268–72 (*July–Aug.*, 1950).

Pure Au and electrolytic Cu were melted together in a graphite tube and cast to a wire 1 mm dia. and 5 cm long, which was annealed, at 800°c for 2 hr and slowly cooled for 15 hr. Resistance of the specimens was measured during heating and cooling using a current-potential method. From changes of resistance during heating and cooling the transformation temperature was found to lie between 375 and 392°c. The thermo-electric power against Pt was measured (value between 20 and 25 μV deg.$^{-1}$c) and showed a maximum between 390 and 400°c. The peaks correspond to the anomalous resistance region just above the transformation temperature. The sign of the absolute thermo-electric power of the Cu_3Au superlattice alloy is positive in both ordered and disordered states, which result is not consistent with the sign of the Hall coefficient. The results are discussed in terms of zone theory.

C. A. HOGARTH

537.363

1856. The temperature dependence of the electrophoretic mobility of horse serum albumin. I. WATANABE, N. UI AND M. NAKAMURA. *J. Phys. Coll. Chem.*, **54**, 1366–70 (*Dec.*, 1950).

Electrophoretic mobilities of crystalline horse serum albumin B (according to Kekwick) have been measured at different temperatures in phosphate buffer (*p*H

7·7, ionic strength 0·2), using a Tiselius apparatus. The mobilities obtained were: $-5{\cdot}8_4$ (2·0°C), $-6{\cdot}8_2$ (8·0°C), $-8{\cdot}9_4$ (16·0°C), $-10{\cdot}0_6$ (20·8°C) and $-14{\cdot}0_0$ (30·6°C) $\times 10^{-5}$ cm²/sec V. Using Henry's equation, it has been made clear that the variation of the electrophoretic mobility of protein with temperature, while depending mostly on the change of viscosity of the solvent, also depends in part on the variation of the valency of the protein ion itself. A.

ELECTRIC DISCHARGES 537.52

537.521.7

1857. Plasma formation under an electric impulse. G. V. Spivak and E. L. Stolyarova. *J. Tech. Phys., USSR*, **20**, 501–15 (*May*, 1950) *In Russian.*

The development of the plasma under the action of a non-repeated impulse at the breakdown of a long spark-gap at low pressure was observed by means of an oscillograph with delayed scan. Also observed was the influence of the field of a shielded magnetic lens on the duration and character of the plasma formation. The magnetic field was found to reduce the statistical time-lag as well as the time required for building up the plasma. It acts in different ways on two distinct phases of the plasma formation. Initially it intensifies the electron-optical mechanism and then accelerates the appearance of the positive space charge. The authors could interpret the mechanism of the whole process of plasma formation for ordinary conditions, in the absence of optical phenomena. Attention is drawn to the marked directional effect in the electron movement, important for the understanding of this first phase and obtaining in the breakdown of long and short spark-gaps. The phenomenon then passes through the phase of the gas-focused beam and of spontaneous electron-optics, the latter delivering the basic directing field and initiating plasma formation proper. The second phase is characterized by the degeneration of the directional electron movement to chaotic movement. Time relations are given and delaying mechanism in the development of the second phase explained, also the character of the transitory processes between the two stages. B. F. KRAUS

537.523.3

1858. Excitation of the high-frequency corona by negative ions. A. M. Prokofiev. *J. Tech. Phys., USSR*, **20**, 802–4 (*July*, 1950) *In Russian.*

It is experimentally established that the high-frequency corona is mainly excited by negative ions at voltages near threshold. To suppress actual corona formation it is sufficient to balance the negative charge on the point of a point-cylinder spark-gap inserted in the circuit by a positive constant potential. In the particular experimental conditions this potential was of the order of some tens of volts, a negligible fraction of the h.f. voltage. All the other parameters remaining unchanged, this potential is ultimately determined by the convection speed of the air current blown past the point of the spark-gap. B. F. KRAUS

537.523.4 : 535.8

1859. A high intensity short duration spark light source. J. A. Fitzpatrick, J. C. Hubbard and W. J. Thaler. *J. Appl. Phys.*, **21**, 1269–71 (*Dec.* 1950).

A cut-cable spark whose effective duration approaches 10^{-7} sec. The light intensity is 900 times > that obtained using RG8U cable cut for 10^{-7} sec duration discharge. The cable described here is coaxial, with Ag conductors fired on the dielectric a compound of $BaTiO_3$. The gain in light intensity is apparently due to both the higher capacitance of the $BaTiO_3$ cable and its very low characteristic impedance. A.

537.525

1860. High-current gas discharge at low pressures. P. C. Thonemann and W. T. Cowhig. Letter in *Nature, Lond.*, **166**, 903–4 (*Nov.* 25, 1950).

537.525 : 537.531

1861. An effect of X-rays on a discharge in very low pressure. A. Canac, G. Maret and L. Goldzahl. *C.R. Acad. Sci., Paris*, **231**, 1054–5 (*Nov.* 13 1950) *In French.*

At first, the current of the discharge increases under irradiation but slowly decreases to its original value upon continuing the irradiation of the gas. On interrupting the irradiation the current diminishes instantaneously to, or is almost, nil. After an interval of 10 to 15 min the current has reappeared. This experiment can be repeated. It is pointed out that the Joshi effect has a similar result. W. SUMMER

537.525.5

1862. The determination of the temperatures of an electrical discharge in a gas. H. Edels. *Rep. Brit. Elect. Res. Ass.* (*Ref. L/T230*) 51 *pp.* (1950).

The report gives a résumé of the methods for determining the electron, excitation, molecular band and gas temperatures of an arc discharge. Thermal equilibrium exists in some discharges in a gas. The variations of the electron temperature with the discharge current, Hg vapour (low) pressure and A pressure (in an A–Ne–Hg mixture) are discussed. The temperature values at low pressures are of the order of 30 000°K, and are 10 000°K at 30 mm Hg. The rotational temperature increases with the pressure and is dependent on the current only to an almost negligible degree. At low pressures the rotational temperature increases with the current. In investigations on the equilibrium temperature in electrical discharges the Saha equation has been elaborated so as to permit the calculation of gas mixture temperatures from the knowledge of the intensity ratios of atom and ion spectral lines and of the total electron concentration. The gas discharge temperature of the whole mixture is inversely proportional to the gas density if the pressure conditions are controlled. The temperature is calculated from the gas density which has been measured. At pressures below 30 mm Hg no thermal equilibrium exists. Thermal equilibrium exists in the column of a high-pressure discharge. An increase in the value of the discharge current will tend to produce thermal equilibrium at a lower pressure. W. SUMMER

537.525.8

1863. Diffusion coefficient of electrons in a gas. D. PALUMBO. *Ann. Geofis.*, **3**, 33–8 (*Jan.*, 1950) *In Italian.*

A procedure of Townsend for the calculation of the diffusion coefficient of electrons in a gas is generalized for the case where the direction of the velocity of the electron after each impact is a function of the velocity vector before the collision. The elongated average free path is explained and discussed. W. SUMMER

537.525.8

1864. Probe measurements for high frequency discharge. II. S. KOJIMA AND K. TAKAYAMA. *J. Phys. Soc. Japan*, **5**, 357–8 (*Sept.–Oct.*, 1950).

For Part I see Abstr. 5865 (1950). A double probe method in which the probe voltage difference (V_c), when the double probe current is zero, is related to the electron temperature. The latter can be determined from V_c and the currents to the two probes; the results obtained for a 7 mm Hg-A discharge (175 Mc/s) agree well with those obtained with another double probe method, also briefly described in the paper. J. D. CRAGGS

537.525.8

1865. Electron removal in helium afterglows. R. A. JOHNSON, B. T. MCCLURE AND R. B. HOLT. *Phys. Rev.*, **80**, 376–9 (*Nov.* 1, 1950).

Observations of the electron density, visible and near u.v. light intensity, and spectrum associated with a 3 000 Mc/s pulsed electrodeless discharge have been made. The electron density data indicate recombination-type electron removal with a constant $\alpha = 1{\cdot}0\times10^{-8}$ cm^3/ion-sec in reasonably good agreement with previous data. During the discharge, the spectrum of atomic He predominates. In the afterglow, the band spectrum of He_2 predominates. The total energy radiated in the wavelength range 2 000 to 8 000 Å is estimated as 0·5 electron volt per electron removed. A maximum in the light intensity occurs a few hundred μsec into the afterglow. The following mechanism is quantitatively consistent with all of our data: He^+ forms He_2^+ by undergoing a triple collision with 2 neutral atoms, after which the molecular He ions combine with electrons. A.

X-RAYS 537.531

537.531 : 535.33

1866. The soft X-ray valence band spectra and the heat of formation of chemical compounds and alloys. K. DAS GUPTA. Letter in *Phys. Rev.*, **80**, 281–2 (*Oct.* 15, 1950).

CATHODE RAYS . POSITIVE RAYS 537.533/.534

537.533.72 : 539.167

1867. Magnetic spectrometer of high resolving power for electron spectroscopy. V. S. SHPINEL. *J. Tech. Phys., USSR*, **20**, 834–46 (*July*, 1950) *In Russian.*

The spectrometer has a non-uniform transverse field of axial symmetry. The electrons emitted by the gun located at the centre of the field are collected on a limiting orbit, where the recording instruments (G.M. counters, or two coincidence counters) are set up. The spectrometer gave 0·5% for the half-width of the conversion line, when a solid angle of $3\times10^{-3}\times2\pi$. The full theory of the instrument, i.e. calculation of the electron trajectories, is given, and photographic methods of focusing discussed. The instrument is suitable for exact measurement of conversion lines and form of the β-spectrum. B. F. KRAUS

537.533.73 : 548.74

Dynamic dispersion of electrons. *See Abstr.* 2190

537.533.74

1868. Multiple scattering of fast electrons in nuclear emulsions. D. R. CORSON. Letter in *Phys. Rev.*, **80**, 303–4 (*Oct.* 15, 1950).

Multiple scattering of 115 ± 5 MeV electrons was determined in Ilford G5 plates, regarding all deflections greater than 4 times the mean deflection as due to single scattering. The average scattering angle was $0{\cdot}17 \pm 0{\cdot}02°/100\,\mu$. This compares with values of $0{\cdot}28°/100\,\mu$ worked out from the theory by Williams [*Phys. Rev.*, **58**, 292 (1940)] as modified by Rossi and Greisen [Abstr. 1331 (1942)] and with $0{\cdot}20°/100\,\mu$ according to the theory by Snyder and Scott [Abstr. 6262 (1949)]. W. F. BERG

537.533.74 : 539.152.1

1869. The scattering of 100-Mev electrons from a heavy nucleus. G. PARZEN. *Phys. Rev.*, **80**, 355–60 (*Nov.* 1, 1950).

Describes and gives the results of a calculation of the scattering from a nucleus with atomic number $Z = 82{\cdot}2$. For 100 MeV electrons the reduced de Broglie wavelength is about one-fourth of the radius of a Pb nucleus and appreciable deviations from pure Coulomb scattering are to be expected. Three different models of the nucleus are considered. In the primary case, the nucleus is assumed to have a uniform charge distribution within its radius. The scattering for this model is calculated by the exact phase-shift method. In the two other models the effects on the scattering of varying the radius and non-uniform charge distributions are investigated. The last two calculations are carried out by perturbation on the first. A.

537.534 : 539.172

1870. Acceleration of stripped C^{12} and C^{13} nuclei in the cyclotron. J. F. MILLER, J. G. HAMILTON, T. M. PURNAM, H. R. HAYMOND AND G. B. ROSSI. Letter in *Phys. Rev.*, **80**, 486 (*Nov.* 1, 1950).

537.534 : 621.384.6

1871. The Birmingham proton synchrotron. L. U. HIBBARD. *Nucleonics*, **7**, 30–43 (*Oct.*, 1950).

This is designed to accelerate protons to 1 300 MeV in an orbit of about 450 cm radius by means of an r.f. accelerating field whose frequency is kept in accurate relationship to the rising magnetic field. The magnet is of annular form constructed from

800 t of C-section low-carbon steel plates. It is excited by two large d.c. generators, driven by a 1 500 h.p., 11 kV, 3-ph., 50 c/s motor with a 36 t flywheel to store the necessary energy for each working cycle. There is one operating cycle per 10 sec, the magnetic field increasing from zero to 15 kilogauss in an almost linear fashion over the 1 sec interval during which the particles are accelerated to the required energy. After a slight further rise the magnetic field falls back, reaching the residual level 4 sec after the start of the cycle. Protons are injected into the orbit when the field is 227·3 gauss by means of a 500 kV Phillips set. The accelerating electrode (Cee) occupies an arc of 96° on the orbit. The accelerating field which gives an energy increment of 226 eV per revolution, increases in frequency from 340 kc/s at injection to 9·6 Mc/s at maximum particle energy. The method of generating this field and keeping its frequency accurately related to the magnetic field is described. The vacuum chamber is made up of 30 beeswax-impregnated stone boxes (porcelain will be used eventually) with an Inconel liner to prevent accumulation of surface charges. The chamber is pumped by means of five 16-in diffusion pumps with a single backing line. L. R. SHEPHERD

537.534 : 621.384.62

1872. The relation between phase stability and first-order focusing in linear accelerators. E. M. McMillan. Letter in *Phys. Rev.*, **80**, 493 (*Nov.* 1, 1950).

537.534.72

1873. On the perfect velocity focusing mass spectrograph. M. Sakai. *J. Phys. Soc. Japan*, **5**, 285–6 (*July–Aug.*, 1950).

Ions leaving an axially symmetrical source are accelerated radially near the end of a chamber in which there is a uniform axial magnetic field. They are deflected by an electric field parallel to the axis, and are collected after flight through a region where only the magnetic field operates. The converging condition is independent of the initial ion velocity, the dispersion is π times that of a 180° spectrograph and the axial symmetry gives high efficiency. A measured mass spectrum of thermoelectrons is given.

T. G. PICKAVANCE

537.534.72

1874. Optics of the ion source of mass spectrometers. R. Vauthier. *C.R. Acad. Sci., Paris*, **231**, 1218–20 (*Nov.* 27, 1950) *In French.*

Formulae are derived for the angular width of the emergent beam and its intensity. The influence of the geometrical dimensions of the source (thickness) is shown to be almost negligible with regard to the resolution of the mass spectrometer. W. SUMMER

537.534.74

1875. Energy dependence of proton-proton scattering, 18·8 to 31·8 Mev. B. Cork. *Phys. Rev.*, **80**, 321–5 (*Nov.* 1, 1950).

Measurements have been made of the absolute differential cross-section of proton-proton scattering at 90° in the centre-of-mass system. The energy of the incident protons was varied from 31·8 MeV down to 18·8 MeV, and an energy interval of ± 1·0% was selected by means of a deflecting magnet. Apparatus using a proportional counter and a triple coincidence method was used to reduce the background. Measurements were made simultaneously, using apparatus for measuring the angular distribution at 31·8 MeV and a single charge integrator for collecting the incident proton beam. The cross-section at 90° in the centre-of-mass system varies approximately as the reciprocal of the energy of the incident protons over the range investigated. Data are presented to show this dependence. Comparison is made with a Yukawa potential well, and with the tensor mode selected by Christian and Noyes. A

537.534.74

1876. Proton-proton scattering at 100 Mev. R. W. Birge. Letter in *Phys. Rev.*, **80**, 490–1 (*Nov.* 1, 1950).

DISCHARGE TUBES . COUNTERS 537.54

537.54 : 537.585

A source of alkali-metal ions. *See Abstr.* 1897

537.542

1877. On the temperature variations in alcohol-argon filled G-M counters. Om Parkash. Letter in *Phys. Rev.*, **80**, 303 (*Oct.* 15, 1950).

537.542 : 778.3 : 539.166

1878. Response of G-M counters and photographic emulsions to high-energy photons. G. J. Hine. *Nucleonics*, **7**, 18–26 (*Oct.*, 1950).

The production of secondary electrons by the absorption of γ-rays is discussed and the results used as a basis for calculating the efficiencies of G.M. γ-counters and the intensifying action of low- and high-Z materials on photographic plates. Comparisons are made between theory and experiment in the case of the ratio of efficiencies of Pb- and Al-walled γ-counters and in the case of the ratio of the intensifying action of Pb and masonite screens.

L. R. SHEPHERD

537.542

1879. Pulses in argon counters. L. Colli, U. Facchini and E. Gatti. Letter in *Phys. Rev.*, **80**, 92–3 (*Oct.* 1, 1950).

The discharge is due to photons which use the emission of photoelectrons by the cathode (bombardment) and by the gas (photo-ionization). Experiments were designed to discriminate between these two types. The photoelectronic pulses are well separated. The building up of the discharge is due to the photoelectric effect on the cathode. The photo-ionization of the gas plays no important part.

W. SUMMER

537.542

1880. Cavity ionization chamber for measurement of absorbed X-radiation energy. T. J. Wang. *Nucleonics*, **7**, 55–71 (*Aug.*, 1950).

The validity of the Bragg–Gray expression relating the energy absorbed at a point in a solid medium to the ionization per unit volume which would be produced in a gas cavity containing this point, is discussed. Experimental data is quoted concerning

the proportionality between the ionization in the cavity and the gas pressure or chamber volume, which follows if the relationship is valid. Deviation from proportionality occurs for low pressures and small volumes. The methods of measuring the quantities involved in the formula, relative electron stopping power of the solid and cavity gas, energy required per ion pair formed in the gas and ionization per unit volume are described. Other methods of measuring the energy absorbed in a solid are compared with the cavity method. L. R. SHEPHERD

537.542

1881. A large ionization chamber for cosmic radiation study. G. POIANI. *Tecn. Ital.*, **5**, 456–61 (*Nov.–Dec.*, 1950) *In Italian.*

An account of the ionization chamber as integration chamber and fast and slow pulse chamber is first given, especially for cosmic radiation research. A large pulse chamber is then described: it is of the coaxial cylindrical type, whose internal volume (*c.* $1 \cdot 2$ m^3) is subdivided into 5 sections. A.

537.542

1882. The use of polytetrafluoroethylene insulators in integrating ion chambers. H. LYSONS. *J. Sci. Instrum.*, **27**, 334–8 (*Dec.*, 1950).

Pocket ionization chambers using polytetrafluoroethylene insulators to space and support the inner electrode from its outer casing have been more reliable than chambers using amber and polystyrene for normal tolerance doses. A.

537.542

1883. Crystals and Geiger counters for scintillation counting. C. E. MANDEVILLE AND H. O. ALBRECHT. Letter in *Phys. Rev.*, **80**, 299–300 (*Oct.* 15, 1950).

537.542

1884. The detection of gamma-ray-induced scintillations from crystals in a photo-sensitive Geiger–Müller counter. C. E. MANDEVILLE AND H. O. ALBRECHT. Letter in *Phys. Rev.*, **80**, 300 (*Oct.* 15, 1950).

537.542 : 539.166

1885. Measurement of gamma-ray energies with the scintillation counter. E. H. BELCHER. Letter in *Nature, Lond.*, **166**, 826–7 (*Nov.* 11, 1950).

537.542

1886. A self-triggering cloud-chamber counter. E. L. FIREMAN AND G. M. MCHANEY. Note in *Rev. Sci. Instrum.*, **21**, 813–15 (*Sept.*, 1950).

537.542 : 621.3.018.75 : 621.317.757

1887. A simple differential pulse height analyzer. K. I. ROULSTON. *Nucleonics*, **7**, 27–9 (*Oct.*, 1950).

An a.c. coupled Schmitt trigger circuit forms a discriminator. A number of these are biased off a single potentiometer network to provide a series of voltage levels. Each trigger circuit is followed by a phase-splitter and a cathode follower. When the incoming voltage pulse is sufficient to trigger a given discriminator the cathode follower receives a positive pulse from the cathode of the phase splitter in that channel, but if the pulse triggers the next highest channel also, a negative pulse is passed back from the plate of that phase splitter to the grid of the cathode follower in the lower channel, thereby cancelling the positive pulse. In this way a positive output pulse goes to the scaling unit only in the highest channel attained by the pulse. A kicksorter of this type requires only 33 electronic valves for 10 channels (excluding scaling units and power supplies). L. R. SHEPHERD

537.542 : 621.318.572

1888. Simple and efficient pentode scalers. P. N. SUNDARAM, S. K. SURI, A. SAGAR AND U. C. GUPTA. *J. Sci. Industr. Res.*, **9B**, 239–41 (*Oct.*, 1950).

A power-of-2 scaler employing 2 pentodes with resistive loads is described in which the retroaction is brought about by coupling opposite screen grids and anodes. Negative impulses applied to the commoned suppressor grids trip the circuit from one stable state to the other. Positive pulses have no effect. Units may be simply joined to give multiples. Resolution is ~ 10 μsec. A. J. KENNEDY

537.542

1889. Expansion valve for triggered cloud chambers. J. L. ZAR. Note in *Rev. Sci. Instrum.*, **21**, 812 (*Sept.*, 1950).

IONIZATION . THERMIONICS 537.56/.58

537.564

1890. Excitation and ionisation of atoms by electron impact—the Born and Oppenheimer approximations. I. D. R. BATES, A. FUNDAMINSKY AND H. S. W. MASSEY. **II.** D. R. BATES, A. FUNDAMINSKY, J. W. LEECH AND H. S. W. MASSEY. *Philos. Trans. A* (*No.* 860) 93–143 (1950).

An examination of the theoretical methods used in the study of inelastic collisions between electrons and atoms at low energies (*c.* 50 eV). The Born approximation is argued to overestimate the cross-section for excitation from states p to q if the interaction between these states is large (through neglect of the reverse transition) and to underestimate it if the interaction is small (due to neglect of other transitions from state p). The same criticisms also apply to the Oppenheimer approximation, which is also found to be ambiguous in that it introduces an interaction which depends on the final state of the system alone, and which is not necessarily equivalent to any that can be written in terms of initial states when calculated wave-functions are used. In dealing with complex atoms both methods are forced to use wave functions which are too large, due to neglect of electron repulsion. It is shown that the Oppenheimer approximation leads to a pronounced maximum in the cross-section just above the threshold energy and that the Born approximation leads to a maximum more like that indicated by the few available experimental results. Several particular cases are discussed. J. R. MADDOX

537.565

1891. The mobilities of molecular and atomic rare gas ions in the parent gases: helium, neon and argon. J. A. HORNBECK. Letter in *Phys. Rev.*, **80**, 297–8 (*Oct.* 15, 1950).

Short pulsed Townsend discharges at different field strengths suggested the presence of two distinct ionic species in each of the three gases. In He the two

mobilities were 18 and 9·4 cm²/volt-sec. The latter, observed at all field strengths, is identified with He^+ and the former with He_2^+. The experiment is held to resolve the previous disagreement between experimental measurements, and is in agreement with a calculation of Massey and Mohr [*Proc. Roy. Soc. A*, **144**, 188 (1934)]. J. R. MADDOX

537.58 : 621.385.032.216

1892. Boride cathodes. J. M. LAFFERTY. Letter in *Phys. Rev.*, **79**, 1012 (*Sept.* 15, 1950).

The thermionic properties of the alkaline-earth and rare-earth borides were studied. LaB_6 gave the highest emission ($A = 29$ A/cm² °K², $\phi = 2{\cdot}66$ eV). No activation is necessary, a simple outgassing at 1 400–1 600°C being sufficient. The pulse and d.c. emissions are the same. A. H. W. BECK

537.583

1893. The electric field at a thermionic cathode as a function of space current. P. L. COPELAND AND D. N. EGGENBERGER. Letter in *Phys. Rev.*, **80**, 298 (*Oct.* 15, 1950).

537.583 : 621.385.032.216

1894. The use of radioactive elements in the study of oxide cathodes. J. DEBIESSE. *Onde Elect.*, **30**, 351–5 (*Aug.–Sept.*, 1950) *In French.*

The various possibilities of a study of cathodes by tracer techniques are considered. The radioactive isotopes $^{140}_{56}Ba$, $^{90}_{38}Sr$ and $^{89}_{38}Sr$ were used. The mass of Ba and Sr evaporated from the cathode to the other electrodes were measured, and it was found that the masses of Ba and Sr were nearly equal. Cathodes were also treated in the pile at Chatillon and similar results were obtained. Some projected experiments are briefly mentioned. A. H. W. BECK (R)

537.583 : 621.385.032.2

1895. Thorium sulfide as a thermionic emitter. T. E. HANLEY. Letter in *J. Appl. Phys.*, **21**, 1193 (*Nov.*, 1950).

The spectral emissivity and thermionic constants were measured for ThS. $\varepsilon = 0{\cdot}4$ and the Richardson constants were $\phi = 3{\cdot}4$ eV, $A = 100$ A/cm², giving only about 0·25 as much emission as ThO_2 at 1 500°C (brightness). Approx. measurements of the rate of evaporation gave a vapour pressure of 10^{-3} mm Hg at 1 870°C (brightness). A. H. W. BECK (R)

537.583 : 621.385.032.216

1896. Base-metal effects in thoria-coated filaments. H. NELSON. Letter in *J. Appl. Phys.*, **20**, 1194–5 (*Nov.*, 1950).

The effect of base metal and bonding on activity was investigated. Because of the high expansion coefficient ThO_2 bonds best to Pt and Ta and worst to W. The emission builds up at much lower temperatures on Ta than on Pt, but at 1 900°K (brightness) all base metals give about 5 A/cm². At lower temperatures the emission is best when a Mo base wire is used, e.g. at 1 800°K (brightness) the Mo base gave 3·1 A/cm², while Ta gave only 2·0 A/cm². A. H. W. BECK (R)

537.585 : 537.54

1897. A source of alkali-metal ions. M. M. BREDOV. *J. Tech. Phys., USSR*, **20**, 476–9 (*April*, 1950) *In Russian.*

The source uses the ionization of the alkali metal atoms on heated W and Ta surfaces. A molecular beam of alkali halides, such as KCl, RbCl, etc., leads, apart from the ionization of the alkali-metal atoms, to the dissociation of the halide molecules, thus again to the evaporation of atomic ions. The source satisfies the following conditions: (1) minimum evaporation of the salt in the working volume of the apparatus; (2) minimum percentage of the neutral component in the ion beam; (3) sufficient stability of the ion beam (5–10%) which, however, must be controllable within certain limits; (4) sustained operation (100 hr); (5) densities of ionic current 0·5–1·0 mA/cm² for a total current of 1–2 mA. The ions of the source are very homogeneous, if purity of salt is guaranteed; magnetic analysis could not detect any traces of ions different from ordinary alkali-metal ions. B. F. KRAUS

537.585 : 621.387

1898. Positive-ion emission, a neglected phenomenon. W. C. WHITE. *Proc. Inst. Radio Engrs*, **38**, 852–8 (*Aug.*, 1950).

The major phenomena of positive ion emission are briefly described. A leak detector has been constructed consisting of a diode whose anode and cathode are made of Pt sheet. The geometry is concentric, the cathode being outside the heated anode. Air passes through the anode-cathode space and if there is any contamination by halogens the positive ion emission increases considerably. Such a device may be used for detecting leaks from completely sealed Freon refrigerator units, or it can be used to test vacuum systems using a halogen as a tracer. A few parts in 10^5 of Freon can be detected in air. A. H. W. BECK (R)

COSMIC RAYS 537.591

537.591.1

1899. Investigation of cosmic rays in the stratosphere. S. N. VERNOV, N. L. GRIGOROV AND A. N. CHARAKHCHYAN. *Izv. Akad. Nauk, SSSR, Ser. Fiz.*, **14** (*No.* 1) 51–63 (1950) *In Russian.*

Surveys the observations at balloon heights by Vernov over several years, using counter systems. Results are given for telescopes at various inclinations, with and without Pb absorbers, showers, and finally showers produced by penetrating particles, identified as primary protons. For the latter investigation, a 3-fold telescope containing 10 cm Pb gave master pulses serving a hodoscope of 21 Geiger counters, arranged in 2 arcs below the telescope. The records were produced at ground level by radio. The effects attributable to electrons, mesons and protons are separately evaluated. E. P. GEORGE

537.591.1

1900. On the origin of cosmic rays. A. AMERIO. *Atti Accad. Naz. Lincei* (*R.C. Cl. Sci. Fis. Mat. Nat.*), **9**, 9–15 (*July–Aug.*, 1950) *In Italian.*

It is suggested that the origin of cosmic radiation lies in the pressure of the radiation. According to K. Schwarzschild the pressure on a spherical surface increases rapidly with increasing radius as long as it is about one-third of the incident wavelength, and then decreases with an increasing radius and rapidly

approaches its limiting value. Material particles that are emitted by the sun move at some 3 000 km/s which is negligible as compared with the velocity of the cosmic rays. However, the sun is relatively small and at a low temperature. The density of the radiation and, therefore, the pressure created by it, are very small. On the sun the pressure is about 18 G for a sphere of 1 000 Å diameter. For temperatures at least 4 times that of the sun the gravitational forces—as against pressure—are negligible. The energy of a particle of 2 000 Å dia. emitted from a star (NGC 6545) at 140 000°C is in excess of 10^{17} eV. The energy of an atomic nucleus is $> 10^9$ eV. The most likely sources of cosmic radiation as explained by this hypothesis are novae and supernovae. In hitting the H layer of the atmosphere (atmospheric pressure 0·02 mm Hg; free path of a molecule about 2 000 Å, i.e. dia. of the irradiating particle) showers of elementary particles are produced and heavy nuclei can be introduced into cosmic radiation. W. SUMMER

537.591.1

1901. On fast neutron in cosmic rays. G. YOSHII. Note in *J. Phys. Soc. Japan*, **5**, 280–1 (*July–Aug.*, 1950).

A result is given of the neutron flux deduced from a coincidence-anticoincidence of counters, using a paraffin converter. E. P. GEORGE

537.591.1

1902. The mean free path of the *N* component of the cosmic radiation. G. SALVINI. Letter in *Nuovo Cim.*, **7**, 786–9 (*Sept.* 25, 1950).

A critical discussion is given of experiments intended to measure the mean free path of the *N* component of cosmic rays, and all methods are shown to reduce to a system of 4 layers, the 1st and 3rd being absorbing material in which interactions of the *N* component take place, and the 2nd and 4th detecting equipment which determines whether such interactions have taken place in the absorbing layers. Apparatus of the Tinlot type is considered to be in general superior to the earlier penetrating shower arrangements of Wataghin and Janossy, but to be still subject to uncertainty of efficiency of the detecting layers. The photographic plate is shown to conform more closely than either to the ideal requirements.

J. G. WILSON

537.591.1

1903. The electronic component of cosmic radiation. P. BUDINI. *Nuovo Cim.*, **7**, 868–80 (*Oct.*, 1950) *In Italian.*

The vertical intensity of the electronic component of cosmic rays is calculated on the assumption that it originates from the γ-rays, decay products of neutral mesons, generated in nuclear explosions at high altitudes. The final formulae, which are valid for every present theory on the production of mesons, are specialized, roughly in the case of Oppenheimer multiple production and more accurately in case of plural production. A.

537.591.1

1904. The differential range spectrum of cosmic-ray mesons. L. GERMAIN. *Phys. Rev.*, **80**, 616–19 (*Nov.* 15, 1950).

A counter-controlled cloud chamber has been used to investigate the differential range spectrum of mesons at sea level. The chamber contains 8 Pb plates each $7\frac{1}{2}$ in wide and $\frac{1}{2}$ in thick. A Pb absorber of variable thickness, up to 27 in, may be placed above the chamber. The number of mesons observed to stop in the chamber per unit time has been found for various thicknesses of absorber above the chamber. A plot of the counting rate of particles which stop *v.* the thickness of absorber above the chamber reveals a broad low peak which has its maximum at a 6 in thickness of absorber. The counting rate at the peak is $2{\cdot}20\times10^{-6}$ count/sec/sterad/g, about 10% higher than the counting rate with no absorber. Correction has been made for particles lost through scattering in the absorber. The corrected results show a more marked peak whose maximum occurs with a 9 in thickness of absorber. The counting rate at the maximum of the corrected curve is $3{\cdot}73\times10^{-6}$ count/sec/sterad/g. A.

537.591.1

1905. Momentum distribution of charged cosmic-ray particles at sea level. D. A. GLASER, B. HAMERMESH AND G. SAFONOV. *Phys. Rev.*, **80**, 625–30 (*Nov.* 15, 1950).

A new measurement of the momentum distribution of high energy charged cosmic-ray particles at sea level has been made with a magnetic spectrograph which uses two counter-controlled cloud chambers and a large electromagnet. The spectrum is extended beyond previous determinations to a momentum of 80 BeV/*c*. For the 1 547 measureable sets of tracks recorded the positive-negative ratio is $1{\cdot}26 \pm 0{\cdot}06$. Up to the highest momenta measured the differential spectrum can be represented by an expression of the form $1/p^s$ with $s = 1{\cdot}9$. The positive excess and positive-negative ratio appear to be functions of momentum with the positives predominating at about 1·3 BeV/*c*. Except for this the positive and negative spectra are very similar. Although the effect is barely outside statistical uncertainty there seems to be an anomalous dip in the momentum distribution at about 3 BeV/*c*. There seems to have been a small diurnal variation in the spectrum during the time occupied by the experiment, 1 BeV/*c* particles being favoured during the day, and 3 BeV/*c* and 6 BeV/*c* particles being favoured at night. These effects are discussed and the present results are compared with data of other experimenters. A.

537.591.1

1906. A critical examination of the gravitational theory of the origin of cosmic rays. P. J. D. GETHING. *Proc. Roy. Soc. A*, **204**, 278–94 (*Dec.* 7, 1950).

The observational data which any theory of the origin of primary cosmic radiation should explain and the comparative merits of the various theories so far propounded are examined. In particular, Milne's suggestion concerning a possible gravitational acceleration in intergalactic space is considered in detail, and his somewhat involved analysis is replaced by a simpler method of derivation by means of an alternative time-scale. The energy spectrum and possible total intensity of gravitationally accelerated material are examined; it is shown that an expression can be obtained for the former which is consistent with cosmic-ray data, but because the world-model

considered is not sufficiently sharply defined, no order of magnitude can be obtained for the latter. It thus appears that a gravitational theory of cosmic radiation can account for most of the main features of the observational data, and as regards the remaining features, although the present theory is incomplete, it presents no actual inconsistencies with observation. A.

537.591.1

1907. On the development of the nucleon component of the cosmic radiation in air. H. Messel and D. M. Ritson. *Proc. Phys. Soc., Lond. A*, **63**, 1359–65 (*Dec.*, 1950).

The development of the nucleon component in air is considered in terms of a model which is an extension of that proposed by Heitler and Jánossy [Abstr. 4162 (1949)]. The numerical results obtained are compared with experiment, and good agreement is found. A.

537.591.15

1908. Some questions concerning cascade theory. S. E. Belenkiĭ. *Izv. Akad. Nauk, SSSR, Ser. Fiz.*, **14** (*No.* 1) 95–114 (1950) *In Russian.*

The historical development of the theory of electron cascade showers is traced in detail. Particular attention is given to methods of solution in which ionization loss is included. An account is also given of methods, developed largely by the author, for solving the equations taking into account the rapid change of photon cross-sections with energy; this being particularly important in heavy elements. The cascade moments are given, and hence the solution of the fluctuation problem. Finally, a radial distribution function is given, based on Rutherford and Compton scattering of the cascade particles. E. P. GEORGE

537.591.15

1909. Consideration of the cascade development of the penetrating component of extensive showers. A. Borsellino and G. Salvini. *Nuovo Cim.*, **7**, 790–4 (*Sept.* 25, 1950) *In Italian.*

Recent experimental results and interpretations are critically discussed. A particular solution of the diffusion equations for nucleons and mesons is studied, corresponding to the production of a single shower generated by a high-energy nucleon. A theoretical expression is obtained for the ratio—at various altitudes—between the number of star-producing particles and the total number of penetrating particles. Collating values of parameters from other phenomena, results are in fair agreement with experiment. The calculation tends to support—for mesons of not too high energy—the single production theory. L. PINCHERLE

537.591.15

1910. Contribution to the study of extensive showers. II. E. Amaldi, C. Castagnoli, A. Gigli and S. Sciuti. *Nuovo Cim.*, **7**, 816–34 (*Oct.*, 1950) *In Italian.*

Completes the discussion of the experimental data obtained at 3 500 m above sea level [see Abstr. 8843 (1950)]. Local multiplication of the shower particles has been examined and a fairly good agreement found between the experimental and theoretical results. It is found that the discrepancy between the theoretical and experimental values of the exponent γ of the integral size shower spectrum is not due to the particular lateral particle distribution used in the calculation; in fact the theoretical value of γ is much too insensitive both to the behaviour of the distribution in the vicinity of the shower axis, and to the presence or absence of a "tail" in it, for this discrepancy to be attributed to its actual form. It could be due, however, to the presence of showers which have not yet reached their maximum development. A.

537.591.15

1911. The barometric effect for large cosmic-ray bursts under thick absorbers at 11 500 feet elevation and the absorption mean free path for very high energy nuclear collisions. T. G. Stinchcomb. Letter in *Phys. Rev.*, **80**, 479–80 (*Nov.* 1, 1950).

537.591.15

1912. *N*-component in extensive air showers. K. Greisen, W. D. Walker and S. P. Walker. *Phys. Rev.*, **80**, 535–45 (*Nov.* 15, 1950).

The high-energy *N*-component, capable of producing penetrating showers, has been found to have an intensity near the cores of air showers about 60% as great as that of the non-interacting penetrating particles, and about $\frac{1}{2}$% as great as that of the electrons. The ratio of charged to neutral *N*-component is about 1·5. Large penetrating showers are more frequently observed to be associated with air showers than are small penetrating showers. It is suggested that all of the *N*-component in the lower atmosphere belongs to extensive showers and contributes to the shower development. Near the core, the lateral density distribution of the *N*-component is found to be as strong as that of the electrons. It is shown that this results from purely geometric considerations, provided one accepts the concept of a core containing *N* component of great energy, continually feeding out lower-energy particles to the side. A.

537.591.15

1913. Mean free path of penetrating shower producers. W. D. Walker, S. P. Walker and K. Greisen. *Phys. Rev.*, **80**, 546–8 (*Nov.* 15, 1950).

The collision mean free path has been measured in C and in Pb for both neutral and charged particles capable of producing penetrating showers. The results are practically equal for the neutral and charged particles, and average 160 ± 10 g/cm² in Pb and 81 ± 5 g/cm² in C. The indicated cross-section in C is significantly less than the geometric cross-section. The ratio of neutral to charged primaries was found, after correction, to be $0{\cdot}84 \pm 0{\cdot}13$. A.

537.591.1

1914. On a difference equation method in cosmic-ray shower theory. W. T. Scott. *Phys. Rev.*, **80**, 611–1 (*Nov.* 15, 1950).

The recent results of Snyder and Bhabha–Chakrabarty for the cascade theory of cosmic-ray showers are shown to be derivable from a general approach involving the use of the Laplace and Mellin transforms, and a general and powerful method, due to Snyder, for solving the resulting difference equations. Boundary conditions are introduced in a natural and automatic way, and the accuracy of the solution is

limited by the possible ways of evaluating the resulting triple complex integral. A.

537.591.5

1915. The positive excess and east-west asymmetry of the penetrating component of cosmic rays between sea level and 7 500 m altitude. I. F. Quercia, B. Rispoli and S. Sciuti. *Nuovo Cim.*, **7**, 715–47 (*Sept.*, 1950) *In Italian.*

Measurements of the positive excess of mesons in the atmosphere at 90, 3 500, 5 100 and 7 300 m in the vertical direction and at 60° E and W at 3 500 m, made with a magnetized iron lens of the Bernadini type are described. These are interpreted on the basis of plural production of mesons, and it is concluded that the data fit best with a scheme in which positive, negative and neutral mesons are formed with equal probability, and that about 20% of the incident energy (assumed as protons of spectrum $E^{-2\cdot8}$) appears as mesons. The zenith-angle variation of positive excess is explained in terms of the deflection of particle trajectories in the earth's magnetic field. Data concerning the E–W asymmetry of meson intensity are obtained in the same experiments. J. G. WILSON

537.591.5

1916. Diurnal variation of primary cosmic-ray heavy nuclei. J. J. Lord and M. Schein. Letter in *Phys. Rev.*, **80**, 304–5 (*Oct.* 15, 1950).

Previous results [Abstr. 6621 (1950)] have been confirmed at the greater altitude of 100 000 ft. The day/night ratio of the flux of heavy nuclei is $2\cdot55 \pm 0\cdot26$, and is the same for all atomic numbers from $Z \sim 10$ to 26. E. P. GEORGE

537.591.5

1917. Latitude and altitude dependence of the local hard showers of cosmic rays. T. G. Walsh and O. Piccioni. *Phys. Rev.*, **80**, 619–24 (*Nov.* 15, 1950).

The latitude effect of the local hard showers penetrating at least 350 g/cm² of Pb has been measured at two aeroplane altitudes, and found to be $(12 \pm 2)\%$ between Rome, New York, and Canal Zone. The two separate latitude effects, obtained respectively at 30 500 ft (300 g/cm²) and at 25 000 ft (383 g/cm²) coincide within the experimental errors. This slow dependence on altitude of the latitude effect seems to allow an estimate of the energy of the hard shower producing particles as they arrive at the apparatus. An average energy of 20 to 30 BeV is obtained from the present data and the current ideas on the absorption of the nucleonic component. This large value is discussed in connection with other experiments and in view of the fact that at sea level or at mountain altitudes pi-mesons of that energy have a large probability of undergoing a nuclear collision before decaying into mu-mesons. The measured altitude dependence of hard showers gives for the absorption mean free path of the producing radiation in air, the value of 112 ± 2 g/cm², if interpreted in terms of a simple exponential. However, because of the geometry of the apparatus, the value 140 g/cm², as obtained from the data according to the Gross transform, seems to be more acceptable when referred to strictly vertical particles. The latitude effect of the normal penetrating component was 1·33 at 30 500 ft, 1·24 at 25 000 ft and 1·08 at sea level. A.

537.591.8

1918. Collimated and wide-angle meson groups in a hard-shower star. M. M. Shapiro and H. Yagoda. Letter in *Phys. Rev.*, **80**, 283–4 (*Oct.* 15, 1950).

An event in a photographic emulsion, in which a star accompanied by a shower of 7 minimum tracks within a cone of semi-angle 25° approx., and 2 slow negative π-mesons emitted at much wider angles, is discussed. The 2 π-mesons each complete their paths in the emulsion, and cause characteristic disintegrations on capture. E. P. GEORGE

MAGNETISM 538

538.1

1919. Calculation of the Curie constant of ferromagnetics and paramagnetics based on the concept of intermittent activation. R. Forrer. *C.R. Acad. Sci., Paris*, **231**, 1130–1 (*Nov.* 20, 1950) *In French.*

The calculations are based on theoretical ideas advanced previously [Abstr. 5943, 6627 (1950)]. Calculated and observed Curie constants agree closely for Fe, Ni, Co, Cu^{++}, Mn^{++}.

E. P. WOHLFARTH

538.11

1920. On the problem of Maxwell stresses. A. Sommerfeld and F. Bopp. *Ann. Phys., Lpz.*, **8** (*No.* 1–2) 41–5 (1950) *In German.*

The magnetostatic force density, calculated as the divergence of a symmetrical tensor, is found to be $\frac{1}{2}\mathbf{B}\,\mathrm{div}\,\mathbf{H} - \frac{1}{2}\mathbf{H}\times\mathrm{curl}\,\mathbf{B}$ for the Maxwell tensor $\frac{1}{2}(H_iB_k + H_kB_i - \delta_{ik}H_jB_j)$, and $-(1/\mu_0)\,\mathbf{B}\times\mathrm{curl}\,\mathbf{B}$ for the modified tensor $(B_iB_k - \frac{1}{2}B_j^2\delta_{ik})/\mu_0$, the torque on a body in this latter case being μ/μ_0 times that given by the Maxwell tensor. R. A. NEWING

538.114

1921. On the ordering effect of antiferromagnetism. Y.-Y. Li. *Phys. Rev.*, **80**, 457–60 (*Nov.*, 1950).

It is shown with the Heisenberg model that in general the Curie temperature of antiferromagnetism depends on the external field. It is also predicted that when an antiferromagnetic crystal with face-centred cubic or close-packed hexagonal magnetic lattice is kept at sufficiently low temperatures, its neutron diffraction pattern should show a transition from that due to an order of the $\alpha\beta$-type to that of the $\alpha\beta_3$-type as the applied field is greatly increased. When the Ising model is assumed, a quasichemical statistical theory shows that a latent heat and sudden disappearance of the neutron diffraction pattern should be observed in the antiferromagnetic transition of a face-centred cubic magnetic lattice. However, this cannot be predicted with assurance, since the Ising model is not reliable. A.

538.214

1922. The magnetic susceptibility of europium and samarium amalgam. D. L. Douglas and D. M. Yost. Letter in *J. Chem. Phys.*, **18**, 1418–19 (*Oct.*, 1950).

538.22

1923. The magnetic properties of copper in solid solution in cobalt and the alloy FeNi. A. J.-P. MEYER AND P. TAGLANG. *C.R. Acad. Sci., Paris*, **231**, 956–8 (*Nov.* 6, 1950) *In French.*

The dependence on copper concentration c of the Curie temperature θ and the saturation moment μ was investigated. For hexagonal Co–Cu μ was found to decrease linearly with c, with a slope $-0{\cdot}71\ \mu_B$ per electron. For face-centred cubic FeNi–Cu the slope is $-0{\cdot}97\ \mu_B$ per electron as in Ni–Cu.

E. P. WOHLFARTH

538.22

1924. Thermomagnetic investigation of boroferrites. R. BENOIT. *C.R. Acad. Sci., Paris*, **231**, 1216–18 (*Nov.* 27, 1950) *In French.*

Measurements were made of susceptibility as a function of temperature for compounds having the general formula $B_2O_3 . Fe_2O_3 . nMO$, where M = Mg, Cu, Co, Ni, Fe and $n = 2, 4$. The results are sensitive to ferromagnetic impurities and high temperature heat treatment is necessary to obtain reversible curves. These indicate that the Curie–Weiss law is obeyed above about 700°C; values of C and θ_p are given and discussed. E. P. WOHLFARTH

538.22 : 537.311 : 538.63

1925. On the properties of [a] ferromagnetic alloy of manganese and bismuth at low temperatures. II. Electrical conduction and galvanomagnetic effects. K. KONDO. *J. Phys. Soc. Japan*, **5**, 307–10 (*Sept.–Oct.*, 1950).

In part I [Abstr. 5130 (1950)] results of magnetic and thermal measurements were reported. For the same MnBi alloy specimen the electrical properties were investigated. The specific resistivity was found to be large, $\rho = 424\ \mu\Omega$ cm at R.T., and the temperature coefficient small and positive. The Hall e.m.f. is positive and a linear function of field and also of magnetization; it exhibits an anomalous temperature variation at low temperatures. The change of resistance in a magnetic field was also measured.

E. P. WOHLFARTH

538.221

1926. Anisotropy of the magnetic permeability of monocrystals of iron silicide in the range of weak magnetic fields. A. L. GOLDMAN, V. V. DRUZHININ AND R. I. YANUS. *J. Tech. Phys., USSR*, **20**, 571–8 (*May*, 1950) *In Russian.*

It is shown experimentally that in the range of weak magnetic fields the minimum permeability of monocrystalline disks of an alloy Fe + 3% Si is obtained by magnetization along the diagonal axis of the cubic lattice, the maximum permeability along the tetragonal axis. An anisotropy conforming to N. S. Akulov's well-known law of anisotropy is observed only for magnetizations far exceeding the range of the maximum permeability. This invalidates the statements of Williams and others on the uniform character of the law of anisotropy of the permeability of monocrystals in strong and weak fields. B. F. KRAUS

538.221

1927. Ferromagnetic properties and superlattice formation of iron–nickel alloys. I. S. CHIKAZUMI. *J. Phys. Soc. Japan*, **5**, 327–33 (*Sept.–Oct.*, 1950).

Experiments are described to explain the anomalous magnetic properties of Fe–Ni alloys of the permalloy type. In this part results of measurements at R.T. are described. The notion of "domain fixing" is introduced, meaning a stabilizing of the direction of the magnetization vector during superlattice formation. High permeability is the result of exclusive 180° domain boundary movement. The magnitude of the internal strain responsible is estimated and found to be of the order of the relative contraction during superlattice formation. E. P. WOHLFARTH

538.221

1928. Ferromagnetic properties and superlattice formation of iron–nickel alloys. II. S. CHIKAZUMI. *J. Phys. Soc. Japan*, **5**, 333–8 (*Sept.–Oct.*, 1950).

In this part (see preceding Abstr.) measurements at higher temperatures were carried out to investigate the changes in magnetic properties during cooling. It is found that "domain fixing" takes place above 350°C and that the magnetization vector becomes more and more stabilized in direction as the temperature decreases. A possible mechanism of the effect is proposed, based on the existence of partial directional order. E. P. WOHLFARTH

538.221

1929. Ferromagnetic resonance in nickel ferrite. W. A. YAGER, J. K. GALT, F. R. MERRITT AND E. A. WOOD. *Phys. Rev.*, **80**, 744–8 (*Nov.* 15, 1950).

The ferromagnetic resonance phenomenon in single crystals of NiO Fe_2O_3 has been studied at room temperature at 24 000 Mc/s. Small samples were used in order to avoid electromagnetic cavity-type resonances. The g-factor observed is 2·19. The 1st-order magnetocrystalline anisotropy constant K_1 was found to be $-6{\cdot}27\times10^4$ ergs/cc. The absorption line was very narrow (half-widths less than 100 oersteds) and fits a resonance curve quite satisfactorily. A.

538.222 : 536.48

1930. The magnetic susceptibility of copper caesium sulphate. R. J. BENZIE AND A. H. COOKE. Letter in *Proc. Phys. Soc. Lond. A*, **63**, 1366–7 (*Dec.*, 1950).

During work on hydrated double sulphates of Cu it was found that while the NH_4, K and Rb salts are well-behaved paramagnetics down at least to 1°K, the susceptibility of CuCs sulphate increases sharply between 4° and 3·1°K and exhibits remanence below 3·1°K. This unusual behaviour is the more surprising in that specific heat measurements [Abstr. 1923, 4219 (1950)] indicate that interaction between the ions is weaker in this salt than in the other three.

538.222 : 539.153 : 536.6

1931. Paramagnetic resonance in chromic sulphate alums at room temperature. D. M. S. BAGGULEY AND J. H. E. GRIFFITHS. *Proc. Roy. Soc. A*, **204**, 188–20 (*Dec.* 7, 1950).

Five of the chromic sulphate alums have been investigated by the method of paramagnetic resonance at room temperature. Except for the K alum, a crystalline electric field of trigonal symmetry gives an adequate explanation of the positions and intensities of the lines in the absorption spectrum. The observed widths of the absorption lines correspond closely with those calculated from magnetic dipole interaction. A

538.222 : 539.153 : 536.63

1932. Paramagnetic resonance spectra of five chromic sulphate alums at low temperatures. B. BLEANEY. *Proc. Roy. Soc. A*, **204**, 203–15 (*Dec.* 7, 1950).

These have been examined at temperatures down to 20°K and wavelengths 3 and 10 cm. Their behaviour is markedly different as follows: (*a*) Rb, Cs and CH_3NH_2 alums show the normal spectrum associated with a trigonal splitting at all temperatures, but the splitting decreases as the temperature is lowered, becoming constant below 90°K. The change in the splitting is most marked for Rb, but substantially zero for CH_3NH_2 alum. (*b*) NH_4 alum shows the normal spectrum at high temperatures, with a steadily decreasing splitting down to 80°K; here a crystallographic transition takes place, and the spectrum becomes abnormal, with two splittings. (*c*) K alum behaves like NH_4 alum down to 160°K, below which an anomalous spectrum appears with lines whose intensity increases as the temperature falls. The two splittings in this region are difficult to reconcile with previous measurements of the specific heat of the spin system by other methods.

538.222 : 539.153 : 536.63

1933. Thermal properties of potassium chromic alum between 0·05 and 1°K. B. BLEANEY. *Proc. Roy. Soc. A*, **204**, 216–23 (*Dec.* 7, 1950).

The entropy, specific heat and magnetic temperature (reciprocal of the susceptibility) of potassium chromic alum are measured as functions of the absolute temperature between 0·05 and 1°K. Their interpretation in the light of paramagnetic resonance measurements (preceding Abstr.) is discussed. A.

538.23

1934. Temperature magnetic hysteresis in ferromagnetics. YA. S. SHUR AND N. A. BARANOVA. *J. Exp. Theor. Phys.*, **20**, 183–91 (*Feb.*, 1950) *In Russian.*

Describes tests carried out on specimens of siliceous (3·7% Si) Fe and Ni, in order to investigate the phenomenon of temperature magnetic hysteresis which arises during the cyclic variation of the temperature of a ferromagnetic between 195°c and Curie point with a weak magnetic field. The regularity of variation is shown to depend on the temperature chart of the constants of natural crystallographic anisotropy and magnetostriction. Hysteresis curves are illustrated graphically for: (*a*) siliceous Fe (i) from 195° to 730°c (Curie point) with steady magnetic fields of 9 sizes from 0·03 to 30 Oe, (ii) magnetization dependent on size of external magnetic field, (iii) minimum constant cyclic temperature of — 195°c and maximum ranging from 350° to 510°c while external magnetic field remains unchanged at 0·006 Oe, (iv) with weak magnetic fields; (*b*) Ni, showing dependence on size of external magnetic field. Results are then analysed and the conclusion is drawn that structural variation under the influence of temperature is finally cancelled only at temperatures considerably exceeding Curie point. J. CLEUGH

538.23

1935. Critical considerations on the model theories of hysteresis cycles of magnetic materials. G. MONTALENTI. *Nuovo Cim.*, 7, 748–56 (*Sept.*, 1950) *In Italian.*

Theories founded on Ewing's model and supposing no bond between coercive force and intrinsic induction lead to a relationship of the type $I/I_s = \phi(H/H_c)$ where H_c is the single domain coercive force and I_s is the saturation intrinsic magnetization. It is shown that this relationship holds only for loops having but slight difference from rectangular form.

H. P. MYERS

538.23

1936. Theory of magnetic anisotropy in Alnico V. J. E. GOLDMAN AND R. SMOLUCHOWSKI. Letter in *Phys. Rev.*, **80**, 302–3 (*Oct.* 15, 1950).

The magnetic properties of Alnico V, which are greatly improved on heat treatment and cooling in a magnetic field, are interpreted by considering the anisotropy of the elastic energy accompanying the formation of nuclei of precipitates during the annealing process. The elastic deformation is due to the magnetostriction of the strongly magnetic precipitates and the resulting elastic anisotropy causes preferential growth of nuclei of given orientation. The sensitivity of the magnetic properties of the alloy to composition and grain orientation of the matrix is also explained.

E. P. WOHLFARTH

538.24 : 548.0

1937. Cation distribution in copper zinc ferrite. J. L. SNOEK. Letter in *Phys. Rev.*, **80**, 299 (*Oct.* 15, 1950).

538.245

1938. Investigations on the reversible susceptibility of ferromagnetics. R. S. TEBBLE AND W. D. CORNER. *Proc. Phys. Soc. Lond. B*, **63**, 1005–16 (*Dec.*, 1950).

A mutual inductometer bridge method has been developed to measure the reversible susceptibility κ_r of a ferromagnetic by the application of small alternating fields, to specimens in the form of long wires. The corrections which must be applied because of the finite amplitude of the alternating field and for eddy current effects are investigated and an overall accuracy within about 1% is attained. Typical results are given for Swedish iron which show a marked increase in susceptibility after decarburizing and annealing, and this is discussed in relation to the ideas of Néel. By the evaluation of $\int \kappa_r dH$ over a suitable range of field, the minimum contribution of reversible processes to the total change in magnetization is estimated and found to vary from 10 to 20% for the specimens of Fe and Ni examined. Finally an investigation has been made into the statement of Gans that reversible susceptibility is a unique function of intensity of magnetization and independent of the magnetic history of the specimen; the statement is shown to be true only for specimens which have been brought into a given state of magnetization round a hysteresis cycle, and then only for the regions of higher magnetization. A.

538.248

1939. On the magnetic after effect due to the irreversible displacement of domain boundary. I. S. MAEDA. *J. Phys. Soc. Japan*, **5**, 358–64 (*Sept.–Oct.*, 1950).

Measurements with a ballistic galvanometer of the flux changes in Cr–permalloy at various time intervals

after the change in magnetizing field, indicate that the magnetic effect is always associated with irreversible domain boundary displacements. It is found that the flux change taking place after time t is inversely proportional to t. The results are interpreted in terms of the velocity of domain boundary displacements and a satisfactory interpretation of the dependence of after effects on field is developed.

A. E. DE BARR

538.248 : 621.3.014 : 621.318.013

1940. Relaxation methods applied to the problem of a.c. magnetization of ferromagnetic laminae. O. I. BUTLER AND M. R. SARMA. *Instn Elect. Engrs Paper* 1026, 12 *pp.* [*Early proof issue*].

The distribution of the magnetizing force inside a ferromagnetic lamination subjected to a.c. magnetization at its surface is determined by the application of Southwell's relaxation methods, on the assumption that the static (or d.c.) characteristics of the material are applicable directly at any point in the lamination under dynamic (or a.c.) conditions. The flux and eddy-current distributions, and the "dynamic hysteresis loop" are then evaluated. The alternative conditions of sinusoidal magnetizing force (at the surface) and sinusoidal total flux are considered for a frequency of 50 c/s. Higher frequencies of operation when the surface magnetizing force is of sinusoidal waveform are also considered. A.

ELECTROMAGNETISM . ELECTRODYNAMICS 538.3/.5

538.3

1941. Electromagnetic fields. Theory and applications. I. Mappings of fields. E. WEBER. *London, Chapman and Hall; New York, John Wiley and Sons* (1950) 590 *pp.*

All the different methods for obtaining electric, magnetic and other field distributions from potential functions are described, and there is a complete presentation of all 3-dimensional orthogonal coordinate systems. In addition a chapter is devoted to experimental mapping methods and another to field plotting methods (including graphical and numerical processes). The M.K.S. system of units is used. There are numerous examples at the end of each chapter, and a very extensive bibliography, both of books and original papers. Numerous diagrams and figures make the text easily readable, and practical (numerical) results are emphasized. In the chapter on two-dimensional analytic solutions the subject of conformal mappings is covered more completely, probably, than in any other book. [In appendices there are reviews of vector analysis and Bessel and Legendre functions.] L. S. GODDARD

538.3

1942. Magneto-hydrostatic fields. S. LUNDQUIST. *Ark. Fys.*, **2**, *Paper* 35, 361–5 (1950).

Field equations are obtained for those distributions of electric current which are possible in a conducting fluid at rest. A simple case is treated, where the current is everywhere parallel to the magnetic field, so that there is no ponderomotive force to disturb the equilibrium of the fluid. A. T. PRICE

ELECTROMAGNETIC WAVES AND OSCILLATORS 538.56

538.56

1943. A note on the method of steepest descents with a remark on T. Ljunggren's paper "Contributions to the theory of diffraction of electromagnetic waves by spherical particles." P.-O. LÖWDIN. *Ark. Fys.*, **2**, *Paper* 36, 367–70 (1950).

A modified steepest-descent method is suggested for evaluating integrals occurring in diffraction theory, when a saddle point is near to one of the limits of integration. It leads in some cases to simple approximate formulae which agree well with results obtained previously by elaborate calculations. A. T. PRICE

538.561

1944. On waves in an ionized gas. E. ÅSTRÖM. *Ark. Fys.*, **2**, *Paper* 42, 443–57 (1950).

A study of Alfvén's magneto-hydrodynamic waves in an ionized gas with infinite compressibility. Collisions are neglected. The treatment is the extension to the case of mobile ions of the usual magneto-ionic theory, and shows the connection between the m.h. waves and the ordinary ionospheric waves.

L. PINCHERLE

538.561

1945. Magneto-hydrodynamic shocks. F. DE HOFFMANN AND E. TELLER. *Phys. Rev.*, **80**, 692–703 (*Nov.* 15, 1950).

A mathematical treatment of the coupled motion of hydrodynamic flow and electromagnetic fields is given. Two simplifying assumptions are introduced: first, the conductivity of the medium is infinite, and second, the motion is described by a plane shock wave. Various orientations of the plane of the shock and the magnetic field are discussed separately, and the extreme relativistic and unrelativistic behaviour is examined. Special consideration is given to the behaviour of weak shocks, that is, of sound waves. It is interesting to note that the waves degenerate into common sound waves and into common electromagnetic waves in the extreme cases of very weak and very strong magnetic fields. A.

538.563 : 535.568.1 : 621.396.6 : 621.317.3.029.6

1946. "Hertzian" polarimeter for the study of macroscopic models of active molecules. R. SERVANT AND P. LOUDETTE. *C.R. Acad. Sci., Paris*, **231**, 1052–4 (*Nov.* 13, 1950) *In French.*

A brief description is given of an apparatus for producing and detecting plane-polarized electromagnetic waves of wavelengths 46–100 cm and for measuring the rotation of the plane of polarization which is produced by suitable models, e.g. helices.

C. B. ALLSOPP

538.566 : 535.42

1947. On Bethe's theory of diffraction by small holes. C. J. BOUWKAMP. *Philips Res. Rep.*, **5**, 321–32 (*Oct.*, 1950).

In his paper on the diffraction of electromagnetic waves by a small circular hole in an infinite plane conducting screen, Bethe derives the diffracted field from fictitious magnetic charges and currents in the hole. However, a careful examination of Bethe's theory reveals that, e.g., the electric field is discontinuous in the hole. The reason is that Bethe's ex-

pression for the magnetic current density is in error, as is shown in the present paper for the simplest possible case, viz., the diffraction of a plane-polarized electromagnetic wave impinging on the hole in the normal direction. Though the error in the current density does not invalidate Bethe's formulas for the distant field, the correct electric field in and near the hole differs appreciably from that predicted by Bethe. A.

538.566.2

1948. On the "internal" reflection in a stratified medium with especial reference to the troposphere. G. ECKART AND T. KAHAN. *J. Phys. Radium*, **11**, 569–76 (*Oct.*, 1950) *In French.*

The case of a medium in which the dielectric constant or permeability is continuous and has a monotonic variation in a single direction (z) is considered, and an "internal" reflection is defined as reflection at any point where there is no discontinuity in the dielectric constant or its first derivative. It is shown that such reflection will always occur unless the characteristic impedance of the medium does not vary with z. The same theory is applied to the case of variable transmission lines. The variation of dielectric constant with height in the troposphere is considered in detail, and the effect of such "internal" reflections are shown to be negligible. J. M. HOUGH

538.566.2

1949. On Sommerfeld's surface wave. C. J. BOUWKAMP. Letter in *Phys. Rev.*, **80**, 294 (*Oct.* 15, 1950).

A brief critical discussion of recent papers on the theory of propagation of e.m. waves over a plane earth. The clarification of the controversy over the existence of the surface wave remains that a correct evaluation of the integral along the branch cut appearing in Sommerfeld's original solution yields an expression that contains the surface wave with the negative sign, this being cancelled by the positive term due to the residue of the pole of the integrand.

L. PINCHERLE

538.566.2 : 551.594.6 : 621.396.11

Radio echoes round the globe. *See Abstr.* 2234

538.566.2 : 621.396.11

1950. Reflection and refraction of microwaves at a set of parallel metallic plates. F. BERZ. *Proc. Instn Elect. Engrs, Pt III*, **98**, 47–55 (*Jan.*, 1951) [*Reprint No.* 1038].

The paper deals with the theory of the propagation of microwaves, passing from a homogeneous and isotropic medium into a set of parallel metallic plates. The plane of separation between the set of plates and the homogeneous medium outside is assumed perpendicular to the plates. The incident wave is plane, and its direction of propagation is in the plane containing the perpendiculars to the plates and to the surface of separation. The electric field is parallel to the plates. The method is relatively simple. The study is based on Maxwell's equations and on periodicity and continuity considerations. An analytic method is introduced for the solution of the infinite set of linear equations with an infinity of unknowns, which arises from the continuity conditions at the boundary plane of the plate edges. Formulae are obtained giving the nature, direction, phase and amplitude of the reflected and transmitted waves. The reflected waves follow the usual laws found in the grating theory. In the case when only one non-evanescent plane wave is reflected, the transmission and reflection power coefficients are those obtained at the junction of two semi-infinite transmission lines corresponding to the free-space and the plate medium respectively. The analogy with transmission lines is more complex when two non-evanescent waves are reflected. For the usual angles of incidence and plate spacings the transmission power coefficient is high (maximum 99·5%), and the phase shift on transmission is small. A.

538.566.2 : 621.396.671

1951. Electromagnetic phenomena on ribbon elements gratings. T. SAKURAI. *J. Phys. Soc., Japan*, **5**, 203–7 (*July–Aug.*, 1950).

The various possible types of oscillations near a grating are investigated by a method employing the Hertzian vector. The results are used to explain the action of a non-reflective metal lens consisting of a number of parallel equidistant grating planes.

L. S. GODDARD

538.566.3 : 621.396.11

1952. Variability of sky-wave radio signals under conditions of ionospheric absorption. G. MCK. ALLCOCK. Letter in *Nature, Lond.*, **166**, 902–3 (*Nov.* 25, 1950).

Signal amplitude measurements made near noon on a frequency of 9·15 Mc/s at a distance of 788 km from an emitter are found to be a poor fit to the Rayleigh distribution formula but an excellent fit to a log-normal formula. It is concluded that the ionospheric absorbing region is the main controlling factor and that the amount of absorption varies randomly about a mean value. W. J. G. BEYNON

MAGNETIC EFFECTS 538.6

538.613

1953. Measurement of Faraday effect and Cotton–Mouton effect using transient magnetic fields and a photo-multiplier-type compensator. M. J. WALKER AND R. C. RAYMOND. *J. Opt. Soc. Amer.*, **40**, 766–8 (*Nov.*, 1950).

A photoelectric apparatus is described which measures approximately the Faraday effect and Cotton–Mouton effect in transparent substances in transient magnetic fields, and indicates directly upon an oscilloscope. The apparatus was used to determine the dispersion curve of the Verdet constant in the visible region for methacrylate polymer, styrene monomer, allyl diglycol carbonate monomer, and toluene; and to determine the Cotton–Mouton constant of nitrobenzene. A.

538.63

1954. A study of the magneto-resistance of silicon–iron. R. PARKER. *Proc. Phys. Soc. Lond. B*, **63**, 996–1004 (*Dec.*, 1950).

Iron containing a small percentage of Si in solid solution has an unusually small magneto-resistance.

Longitudinal and transverse curves of $\Delta\rho/\rho$ against field strength were obtained for a number of single and polycrystalline specimens. In large fields the curves show a linear decrease, which is less than 0·02 times that of Ni and Co in the corresponding field range. In small fields various unusual features are found. It is concluded that the small magneto-resistance of polycrystalline Si–Fe is due to the small contribution of individual crystallites and not to an averaging-out process. A.

538.632

1955. On the Hall effect in ferromagnetics. E. M. Pugh, N. Rostoker and A. Schindler. *Phys. Rev.*, **80**, 688–92 (*Nov.* 15, 1950).

With precise measurements at magnetic fields well above those required for saturation, it is shown that the Hall electric field per unit current density consists of two distinct parts. Its value averaged between poles is given by $R_0H + R_1M$, where H and M are the magnetizing force and average intensity of magnetization, respectively, in the sample. The value $R_0 = -0{\cdot}611\times10^{-12}$ volt-cm/amp-oersted indicates 1·16 *s*-band electrons with no *d*-band conduction, 0·6 *s*-band electrons with 30% *d*-band conduction, or something intermediate between these two. The value $R_1 = -74{\cdot}9\times10^{-12}$ volt-cm/amp-oersted suggests the existence of a very large average magnetic field acting on the conduction electrons. An explanation for this is suggested. A.

538.65 : 548.0

1956. Single crystal magnetostriction constants of an iron-cobalt alloy. J. E. Goldman. Letter in *Phys. Rev.*, **80**, 301–2 (*Oct.* 15, 1950).

MOLECULAR AND ATOMIC STRUCTURE 539.1

THEORY OF SOLID STATE 539.11

539.11

1957. On the freeing of electrons when metal atoms are bound together in a compact metal. H. Mayer. *Elektron*, **4**, 341–7 (*Oct.–Nov.*, 1950) *In German.*

The subject is discussed with special reference to the field of the nucleus, and it is shown how experiments on very thin metallic films, e.g. variation of resistivity with thickness, help to an understanding of the problem. C. A. HOGARTH

539.11 : 541.57

1958. Electron transfer in intermetallic compounds. L. Pauling. *Proc. Nat. Acad. Sci., Wash.*, **36**, 533–8 (*Oct.*, 1950).

Reference is made to previous papers [Abstr. 1917 (1947), 2891 (1948), 3360 (1949)]. The analysis of interatomic distances of such intermetallic compounds as AlP, Al_2Au, $PtSn_2$, shows that electron transfer takes place in a great many interatomic compounds, and that the numbers of electrons involved are reasonable, in relation to the changes in valence resulting from loss or gain of electrons and to the partial ionic character of the bonds between unlike atoms and the striving of atoms towards electroneutrality. F. LACHMAN

539.11 : 548.0

1959. Some remarks on the calculation of the cohesive energy of ionic crystals. S. O. Lundqvist and P. O. Fröman. *Ark. Fys.*, **2**, *Paper* 40, 431–8 (1950).

In an attempt to take account of overlap integrals in a Heitler–London calculation, a new approximation procedure is introduced. It is found that the use of Hylleras's method of subtracting the energy of free ions is inadmissible, at least in the case of LiH. J. R. MADDOX

MOLECULAR STRUCTURE 539.13

539.132 : 538.615

1960. The Zeeman effect in oxygen. A. F. Henry. *Phys. Rev.*, **80**, 396–401 (*Nov.* 1, 1950).

Describes the calculation of the energy of magnetic sub-levels belonging to the $^3\Sigma$-state of O_2 in an external magnetic field. A general secular determinant is derived, the roots of which yield the desired energies. The results are particularly useful in the investigation of levels associated with a low value of the rotational quantum number. The perturbation representing the external magnetic field is introduced together with the perturbations leading to the rotational triplets; thus the distortion of the rotational triplets is considered from the beginning of the calculation. The work is performed in two stages to avoid the mathematical difficulties of treating a 9th-order secular determinant. Comparison between theory and experiment is satisfactory. A.

539.133

1961. The structure and dipole moment of hydrazoic acid. E. Amble and B. P. Dailey. Letter in *J. Chem. Phys.*, **18**, 1422 (*Oct.*, 1950).

539.133

1962. Theoretical study of the molecule of nitrogen tetroxide, N_2O_4. O. Chalvet and R. Daudel. *C.R. Acad. Sci., Paris*, **231**, 855–6 (*Oct.* 23, 1950) *In French.*

The N_2O_4 molecule has been examined by the methods of molecular orbitals and the distribution of charges and the bond lengths have been calculated. The latter are in good agreement with those determined by X-ray analysis. [See Abstr. 2642, 2980 (1946)]. J. IBALL

539.133

1963. Magnetic shielding constant of H_2. G. F. Newell. Letter in *Phys. Rev.*, **80**, 476–7 (*Nov.* 1, 1950).

539.133 : 535.343–14

1964. The structure of methyl bromide from microwave spectra. J. W. Simmons and W. O. Swan. Letter in *Phys. Rev.*, **80**, 289–90 (*Oct.* 15, 1950).

539.133 : 537.226.2

Dielectric relaxation in glycerine. *See Abstr.* 1819

ATOMIC STRUCTURE . NUCLEUS ISOTOPES 539.15

539.152.1

1965. Nuclear isomerism and shell structure. R. D. HILL. Letter in *Phys. Rev.*, **79**, 1021–2 (*Sept.* 15); erratum: **80**, 906 (*Dec.* 1, 1950).

Experimental data on isomeric transitions are examined for nuclear level trends as a function of neutron and proton numbers. The trends found are not in agreement with the predictions of the various shell models. J. HUGHES

539.152.1

1966. Effect of finite range interactions in the (jj) coupling shell model. D. KURATH. Letter in *Phys. Rev.*, **80**, 98–9 (*Oct.* 1, 1950).

In this model the spin of the ground state of the nucleus is that of the odd particle if a δ-function interaction between nucleons is assumed [Abstr. 6007 (1950)], but not if an infinite range is used [Abstr. 7428 (1950)]. The transition ranges of a Gaussian interaction in the case of 3 particles in (*a*) the $1d_{5/2}$ and (*b*) the $1f_{7/2}$ shell were calculated using an oscillator potential well. Values around 4×10^{-13} cm were obtained. W. J. SWIATECKI

539.152.1

1967. Characteristics of stable nuclei. G. J. BÉNÉ, P. M. DENIS AND R.-C. EXTERMANN. *J. Phys. Radium*, **11**, 41*D*–47*D* (*Oct.*, 1950) *In French.*

A table is given of the relative values (in general with reference to that of the proton) of the gyromagnetic ratio, the spin, the nuclear magnetic moment and the electric quadrupole moment of stable nuclei. A bibliography is included. J. HUGHES

539.152.1

1968. Polarization correlation of mixed multipoles. I. ZINNES. *Phys. Rev.*, **80**, 386–91 (*Nov.* 1, 1950).

The directional polarization results of Hamilton are extended to cases in which one of the two photons emitted by a nucleus is described by a pure 2^L multipole and in which the second is described by two mixed multipoles. While these polarization functions are still quite simply related to the parameters occurring in the functions describing the correlation between two successive photons neither of whose polarizations is being measured, the relationship is more complicated than for pure multipole photons on account of the explicit dependence of the mixture polarization function on the mixture components and on the interference arising from the mixture. The net result is that the correlation parameters $Q, R, S, \ldots$ obtained from a correlation experiment without polarization are insufficient to describe a polarization correlation experiment when mixtures are involved. A table of polarization correlation functions is given for all pure-mixture transitions up to and including octupoles. Two examples briefly indicating how this table may be used, as well as a table of some useful combinations of the elements of the representations of the 3-dimensional rotation group are included. A.

539.152.1

1969. Nuclear spins of the 2·62-Mev and 3·20-Mev excited states of thorium *D*. H. E. PETCH AND M. W. JOHNS. Letter in *Phys. Rev.*, **80**, 478–9 (*Nov.* 1, 1950).

539.152.1

1970. Evidence from nuclear masses on proposed closed shells at 20 nucleons. W. LOW AND C. H. TOWNES. *Phys. Rev.*, **80**, 608–11 (*Nov.* 15, 1950).

Combining microwave measurements of S and Cl masses with mass spectroscopic and nuclear reaction information, the effect of nuclear shell structure on masses in the region of 20 neutrons or protons is investigated. It is found that except for Ca^{40}, nuclei with 20 neutrons or protons do not show any special stability. A.

539.152.1 : 539.155.2 : 535.338.333

1971. On some regularities in the isotope effect in the spectrum of lead. K. MURAKAWA AND S. SUWA. Letter in *J. Phys. Soc. Japan*, **5**, 382–3 (*Sept.–Oct.*, 1950).

The fine structure of 10 Pb I and Pb II lines was measured by means of a Fabry–Pérot and also a Lummer interferometer. The ratio between the separations $(\lambda_{204}-\lambda_{206})/(\lambda_{206}-\lambda_{208})$ was found to be 0·93, this value being probably an upper limit. The ratio $(\lambda_{206}-\lambda_{207})/(\lambda_{207}-\lambda_{208})$ was found to be between 0·60 and 0·65. The approximate constancy of these values for all lines investigated supports Breit's theory [Abstr. 7432 (1950)]. L. PINCHERLE

539.152.2

1972. Fundamentals of nuclear magnetic resonance absorption. I. G. E. PAKE. *Amer. J. Phys.*, **18**, 438–52 (*Oct.*, 1950).

An introductory treatment of the theory of the method of Purcell and Pound [Abstr. 1351 (1946), 2529 (1948)]. Spin-lattice relaxation and spin-spin interaction is included.

539.152.2

1973. Fundamentals of nuclear magnetic resonance absorptions. II. G. E. PAKE. *Amer. J. Phys.*, **18**, 473–86 (*Nov.*, 1950).

The review is continued [preceding Abstr.] with an outline of experimental technique and some of the applications and practical effects, such as line-broadening, and the influence of molecular and solid structure. The whole article contains about 40 references to original publications.

539.152.2

1974. On nuclear quadrupole moments. R. STERNHEIMER. Letter in *Phys. Rev.*, **80**, 102–3 (*Oct.* 1, 1950).

The effect on the nuclear quadrupole moment of screening by the electron cloud in an atom is estimated using a Thomas–Fermi model. Reductions varying from 4 to 45% are found for the 8 elements studied. W. J. SWIATECKI

539.152.2

1975. Magnetic moments of odd nuclei. A. DE-SHALIT. Letter in *Phys. Rev.*, **80**, 103–4 (*Oct.* 1, 1950).

An empirical rule is given, stating that the addition of either two protons or two neutrons to an odd nucleus, provided it leaves its spin unchanged, "pushes" its magnetic moment away from a line intermediate to the Schmidt lines, i.e. towards a better agreement with the naïve one-particle model. L. PINCHERLE

539.152.2

1976. Chemical shifts in the magnetic resonance of F^{19}. H. S. Gutowsky and C. J. Hoffman. Letter in *Phys. Rev.*, **80**, 110–11 (*Oct.* 1, 1950).

Initial observations on the dependence of the nuclear magnetic resonance frequency of F^{19} on the nature of the chemical compound containing this nucleus suggest that, in the simpler co-valent compounds, the effect depends on the position in the periodic table of the element to which F^{19} is bound. For elements in a given period the magnetic shielding decreases with increasing atomic number, while for elements in the same group the shielding increases with increasing atomic number. The shielding appears to be temperature-independent. Multiple resonances were found in several fluorocarbons containing F-atoms in different structural positions.

L. PINCHERLE

539.152.2

1977. Nuclear moment discrepancies in gallium and indium. H. M. Foley. Letter in *Phys. Rev.*, **80**, 288–9 (*Oct.* 15, 1950).

539.152.2

1978. Spectroscopic value of the magnetic moment of $_{83}Bi^{209}$. F. M. Kelly, R. Richmond and M. F. Crawford. Letter in *Phys. Rev.*, **80**, 295–6 (*Oct.* 15, 1950).

The h.f.s. was observed by means of a 21 ft concave grating. From the separations of 14 levels of Bi III, IV and V, the nuclear magnetic moment of Bi^{209} was calculated by means of the Goudsmit–Fermi–Segrè formula. Corrections were applied for the finite size of the nucleus and the volume distribution of the magnetic moment, and, on the appropriate levels, for configuration interactions. The final value is $4{\cdot}10 \pm 0{\cdot}08$ n.m., to be compared with the value 4·082 determined from the gyromagnetic ratio.

L. PINCHERLE

539.152.2

1979. On the space exchange magnetic moments of light nuclei. L. Spruch. *Phys. Rev.*, **80**, 372–5 (*Nov.* 1, 1950).

The calculations were based on Sachs' phenomenological theory and on the independent particle model. Spin exchange moments were not included. Uncertainties in the parameters required to characterize the shell dimensions and the neutron-proton interaction, which was assumed to be of an entirely exchange nature, cause the calculated values to be uncertain by a factor of about 3; they are probably too large. For *L-S* coupling, the values found in the 1*p* shell for ^2P states for Li^7, Be^9, B^{11}, C^{13} and N^{15}, and in the 1*d* shell for ^2D states for Ne^{21}, Na^{23}, Cl^{37} and K^{39} were $-0{\cdot}04$, $-0{\cdot}01$, $0{\cdot}1$, $0{\cdot}05$, $0{\cdot}1$, $-0{\cdot}4$, $-0{\cdot}1$, $0{\cdot}4$ and $0{\cdot}4$ nuclear Bohr magnetons, respectively. For *j-j* coupling, the values found for $B^{11}(p_{3/2})^{-1}$, $C^{13}(p_{1/2})$ and $N^{15}(p_{1/2})$ were $0{\cdot}2$, $-0{\cdot}09$ and $0{\cdot}1$, respectively. The signs and ratios of these values are such as to lead to the conclusion that the simple models used here cannot be brought into agreement with the data by the addition of space exchange contributions alone. The magnitudes are nevertheless reasonably large in some cases, and indicate that they must be included in any consistent theory of nuclear magnetic moments. A.

539.152.2

1980. The spin and magnetic moment of the rhodium nucleus. H. Kuhn and G. K. Woodgate. Letter in *Nature, Lond.*, **166**, 906 (*Nov.* 25, 1950).

539.152.2

1981. Nuclear spins of neodymium 143 and 145. B. Bleaney and H. E. D. Scovil. Letter in *Proc. Phys. Soc., Lond. A*, **63**, 1369 (*Dec.*, 1950).

The method of paramagnetic resonance has been applied to determine the nuclear spins of neodymium 143, 145 together with the ratio of their magnetic moments. It is found that the spin is 7/2 for both isotopes, and the ratio of the moments (143/145) is $1{\cdot}61 \pm 0{\cdot}01$.

539.152.2 : 537.534

1982. A direct determination of the magnetic moment of the proton in nuclear magnetons. F. Bloch and C. D. Jeffries. Letter in *Phys. Rev.*, **80**, 305–6 (*Oct.* 15, 1950).

The ratio of the proton magnetic moment to the nuclear magneton is equal to the ratio of the nuclear resonance frequency and orbital rotation frequency of the proton in a given magnetic field. A beam of 20 keV protons was directed into a small decelerating cyclotron between the polepieces of an electromagnet shimmed to give a very homogeneous field ($\sim 5\,300$ gauss). A voltage of about 100 V was applied to the dees. The dee frequency was adjusted to an integral multiple (n) of the orbital rotation frequency when the protons were caused to spiral inwards to a detecting probe. Values of n up to 11 were employed in order to obtain the highest possible resolution in the frequency setting. The nuclear resonance frequency of protons in the same field was measured in water in a small nuclear resonance head which was movable within the dee chambers. The value obtained for the proton magnetic moment was $\mu_p = 2{\cdot}79245 \pm 0{\cdot}0002\ \mu_n$. L. R. Shepherd

539.152.2 : 539.164

Alpha radioactivity and the stability of heavy nuclei. *See Abstr.* 2007

539.153

1983. Self-consistent field, with exchange, for Ne III. R. H. Garstang. *Proc. Camb. Phil. Soc.*, **47** (*Pt* 1) 243–4 (1951).

539.153.4

1984. Hartree computation of the internal diamagnetic field for atoms. W. C. Dickinson. *Phys. Rev.*, **80**, 563–6 (*Nov.* 15, 1950).

For an atom or monatomic ion in a magnetic field H there will be an induced shielding field $H'(0)$ at the nucleus given by $H'(0) = (eH/3mc^2)v(0)$ where $v(0)$ is the electrostatic potential produced at the nucleus by the atomic electrons. Using the Thomas–Fermi model, Lamb put this expression into a calculable form. However, in modern nuclear induction and resonance absorption experiments it is important to have a more precise knowledge of the magnitude of this shielding field. In this paper computed values of $v(0)$ are given for all atoms and singly charged ions which have been treated by the Hartree or Hartree–Fock approximations to the self-consistent field method. By interpolation a list of $H'(0)/H$ values for all neutral atoms is given. Although it is impossible to check the accuracy of these values experimentally it is estimated

from other evidence that they can be trusted to within 5%. An exception must be made, however, for the heaviest atoms where the relativity effect becomes appreciable, amounting to an estimated 6% correction to $H'(0)/H$ for $Z = 92$. Finally, the usefulness of accurate values of the atomic shielding field in analysing the total shielding field in molecules is discussed. A.

539.153.4

1985. Wave function for the groundstate of lithium. S. D. MAJUMDAR AND D. C. CHOWDHURY. *Z. Phys.*, **128** (*No.* 4) 455–64 (1950).

A variational calculation for the groundstate of the Li atom is carried out with an anti-symmetrical wave function built up out of the core function and the valence electron function. The resulting improvement in the total energy of the atom is considerable. But contrary to expectation the calculated value of the ionization potential is much inferior to those previously obtained with simple H-like core functions. The integrals occurring are discussed from a uniform viewpoint. A few simple integrals involving either one or two of the inter-electronic distances are first evaluated with the help of two general formulae, and from them the remaining ones are obtained by repeated differentiation with respect to parameters occurring in the exponential part of the integrand. A new method of successive approximations has been developed for minimizing the energy expression. A.

RADIOACTIVITY . α-, β- AND γ-RAYS 539.16

539.16 : 614.8

1986. Protection against radiation hazards. S. WARREN AND A. M. BRUES. *Nucleonics*, **7**, 70–6 (*Oct.*, 1950).

A brief outline of the present state of knowledge of the effects on humans and animals of external radiations and radiation from internal sources.

L. R. SHEPHERD

539.16.08

1987. Dosimetry of thin polonium sources. H. H. ROSSI AND R. H. ELLIS, JR. *Nucleonics*, **7**, 21–31 (*Sept.*, 1950).

Alpha-particle fluxes and ionization doses above thin plane Po sources are calculated. Ionization chamber measurements of the dose are described giving results in fairly good agreement with the theoretical estimates. L. R. SHEPHERD

539.162

1988. Angular correlation: a general proof of the method of D. R. Hamilton. S. P. LLOYD. Letter in *Phys. Rev.*, **80**, 118–19 (*Oct.* 1, 1950).

The expression for the angular correlation between successively emitted particles (using unpolarized detectors) in a nuclear decay scheme is particularly simple if the angular momentum quantization axis is chosen parallel to one of the particles. This theorem, noted earlier for special decay processes [Abstr. 2778 (1940) and 8932 (1950)], is proved generally here, using group theory methods. R. H. DALITZ

539.162

1989. On the directional correlation of successive nuclear radiations. J. A. SPIERS. Letter in *Phys. Rev.*, **80**, 491 (*Nov.* 1, 1950).

539.163.2

1990. On the decay of K^{40}. C. FESTA AND M. SANTANGELO. *Ann. Geofis.*, **3**, 95–112 (*Jan.*, 1950) *In Italian.*

A review of recent determinations of the total disintegration constant λ of K^{40} from the accumulation of Ca in ancient K minerals. A discussion is given of the hypotheses on which this procedure is based, and values for λ, λ_β and λ_e are re-calculated (λ_β = disintegration constant for β-emission, λ_e for K-capture). In particular the branching ratio λ_e/λ_β is found to be $\sim 3 \cdot 3$. L. PINCHERLE

539.163.2

1991. The disintegration of Hf^{181}. W. W. PRATT. Letter in *Phys. Rev.*, **80**, 289 (*Oct.* 15, 1950).

539.163.2

1992. The radioactivity of Am^{242}. G. D. O'KELLEY, G. W. BARTON, JR., W. W. T. CRANE AND I. PERLMAN. Letter in *Phys. Rev.*, **80**, 293–4 (*Oct.* 15, 1950).

From observations of the X- and β-radiations of Am^{242m}, produced by pile-neutron irradiation of Am^{241}, it is concluded that this nucleus decays 60% by β^--emission, 20% by L-capture and 20% by isomeric transition. The β-end point is 628 ± 5 keV, that of Am^{242} being 580 ± 30 keV. The γ-ray of the isomeric transition is tentatively put at 52 keV, and a γ-ray of 38 keV associated with the L-capture process. B. ROSE

539.163.2

1993. Some properties of the 43-day isomer of Cd^{115}. P. S. GILL, C. E. MANDEVILLE AND E. SHAPIRO. Letter in *Phys. Rev.*, **80**, 284–5 (*Oct.* 15, 1950).

539.163.2

1994. Mass assignment of natural activity of samarium. B. WEAVER. Letter in *Phys. Rev.*, **80**, 301 (*Oct.* 15, 1950).

539.163.2

1995. Radioactive isotopes of Ag and Cd. J. R. GUM AND M. L. POOL. *Phys. Rev.*, **80**, 315–17 (*Nov.* 1, 1950).

Ag^{105}: an activity with a half-life of 40 days, has been produced by the following reactions: Rh(α, $2n$), Pd (α, p), Pd(d, $2n$) and Pd(p, n). This activity decays by K-electron capture only. Ag^{110}: an activity with a half-life of 270 days previously reported as 225 days, has been produced by Pd(d, n) and Ag^{109}(d, p) reactions. Cd^{105}: an activity with a half-life of 57 min has been produced by the Cd(n, $2n$) and Pd(α, n) reactions. Decay is accompanied by a 1·5 MeV positron and K-capture. Cd^{109}: an activity with a half-life of 470 days, previously reported as 330 days, has been produced by the Ag(d, $2n$) and Pd(α, n) reactions. A.

539.163.2

1996. The decay scheme of Cl^{39}. R. N. H. HASLAM, L. KATZ, H. J. MOODY AND H. M. SKARSGARD. *Phys. Rev.*, **80**, 318–20 (*Nov.* 1, 1950).

A has been irradiated and Cl^{39} produced by the reaction $A^{40}(\gamma, p)Cl^{39}$. The threshold was found to be 14·2 MeV. The Cl^{39} activity was found to have

2 beta-particles of energies 2·96 and 1·65 MeV, and 2 gamma-rays of energies 1·31 and 0·35 MeV, the low energy gamma-ray having a conversion coefficient of 0·05. A decay scheme is proposed. Consideration of the results show that A^{39} must have a half-life greater than 5 years or a decay energy of less than 0·4 MeV. A.

539.163.2

1997. The disintegration of Ti^{45}. M. Ter-Pogossian, C. S. Cook, F. T. Porter, K. H. Morgan-stern and J. Hudis. *Phys. Rev.*, **80**, 360–5 (*Nov.* 1, 1950).

The positron and photo-electron spectra of 3·05 hr Ti^{45} have been studied. At least 96% of the positron transitions are to the ground state of Sc^{45} with a maximum positron kinetic energy of 1·022 ± 0·01 MeV. Less than 4% of the positron transitions are to an excited level of Sc^{45} at 450 keV. In addition, certain longer-lived activities are found in the chemically separated Ti fraction produced by both deuteron and proton bombardment of Sc oxide. Two of the activities are shown to be P^{32} and Sc^{46} impurities. A.

539.163.2

1998. The beta-disintegration of Th^{233}. M. E. Bunker, L. M. Langer and R. J. D. Moffat. Letter in *Phys. Rev.*, **80**, 468 (*Nov.* 1, 1950).

539.163.2

1999. A 3×10^{-9} sec. isomeric state in $_{63}Eu^{153}$. F. K. McGowan. Letter in *Phys. Rev.*, **80**, 482–3 (*Nov.* 1, 1950).

539.163.2

2000. A two-day Xe^{133} isomer. B. H. Ketelle, A. R. Brosi and H. Zeldes. Letter in *Phys. Rev.*, **80**, 485–6 (*Nov.* 1, 1950).

539.163.2

2001. A note on neutron-deficient europium activities. G. Wilkinson and H. G. Hicks. Letter in *Phys. Rev.*, **80**, 491–2 (*Nov.* 1, 1950).

539.163.2

2002. Neutron deficient radioactive isotopes of tantalum and wolfram. G. Wilkinson. *Phys. Rev.*, **80**, 495–9 (*Nov.* 15, 1950).

Neutron-deficient radioactive isotopes of Ta have been produced by bombardment of Lu with α-particles, of Hf with 10 MeV protons, and of Ta with fast neutrons and protons from 10 to 70 MeV energy. In addition, W isotopes produced by 10 to 70 MeV proton bombardments of Ta, together with their respective Ta daughter activities were studied. The radiation characteristics of the new activities of Ta and W are described. A.

539.163.2

2003. Three new delayed alpha-emitters of low mass. L. W. Alvarez. *Phys. Rev.*, **80**, 519–23 (*Nov.* 15, 1950).

Two new positron-active isotopes, B^8 and Na^{20}, have been found to decay to excited states of Be^8 and Ne^{20}, which in turn decay "instantaneously" by alpha-emission. Their half-lives are 0·65 ± 0·1 sec and ¼ sec, respectively. N^{12} is also found to have a low-energy positron group which leads to an α-unstable excited state in C^{12}. The masses of B^8 and Na^{20} are 8·027 and 20·015, respectively. B^8 decays by a 13·7 ± 0·3 MeV positron, through the same excited state of Be^8 as does Li^8. Estimates of the energies of the excited state in C^{12} and Ne^{20} are made. A.

539.163.2

2004. A coincidence absorption study of the decay of ^{181}Hf. E. W. Fuller. *Proc. Phys. Soc., Lond. A*, **63**, 1348–58 (*Dec.*, 1950).

The decay of 46 day Hf^{181} has been investigated by absorption coincidence techniques using an integral type delayed coincidence recorder, and a special counter with which the absorption curves of low energy electrons may be obtained. The results confirm a previously published scheme for the main mode of decay, namely that a 400 keV β-ray from Hf^{181} leads directly to the 20 μsec metastable state in Ta^{181}. This decays by emission of a 130 keV γ-ray, followed by a 470 keV transition to the ground state. Instantaneous coincidences were found to involve the γ-transitions in the main branch, electrons from γ-rays of 87, 133 and 340 keV, and a β-ray of approximately 440 keV. It is suggested that about 30% of the Hf^{181} nuclei in the 46 day state decay by a highly forbidden γ-transition (133 keV) with an 87 keV γ-ray in cascade to the ground state. This decays through a 440 keV β-transition to an excited state (340 keV) of Ta^{181}. Half-life and conversion coefficient values enable spins and relative parities to be assigned to each of the levels occurring in the decay scheme proposed. A.

539.163.2

2005. The radioactivity of F^{20}. I. J. V. Jelley. *Phil. Mag.*, **41**, 1199–213 (*Dec.*, 1950).

The beta and gamma radiation emitted by F^{20} has been studied by absorption, coincidence and spectrometer techniques. The upper limit of the beta particle spectrum was found to be 5·03 ± 0·05 MeV and gamma-rays of 1·63 ± 0·02 MeV and 2·45 ± 0·06 MeV with an intensity ratio of (8·4 ± 2·6) to 1 were also observed. No gamma-gamma coincidences were found, and it is concluded that the predominant mode of disintegration of F^{20} leads to a 1·63 MeV excited state of Ne^{20}. The total energy release F^{20}–Ne^{20} is 6·66 ± 0·05 MeV, and the mass of F^{20} derived from this value is compared with that obtained from the F^{19} (*dp*) and F^{19} (*nγ*) reactions. A.

539.163.2

2006. The radioactivity of F^{20}. II. R. M. Littauer. *Phil. Mag.*, **41**, 1214–24 (*Dec.*, 1950).

Experiments on the radioactivity of F^{20} are described which give the following results: 3·5% of the disintegrations go direct to the ground state of Ne^{20}, while the remainder leave Ne^{20} in an excited state of energy 1·63 ± 0·02 MeV. The best present estimate of the F^{20} mass is 20·00631 ± 0·00005, corresponding to a total energy release F^{20}–Ne^{20} of 6·87 ± 0·07 MeV. A weak gamma-ray of energy 1·0 ± 0·1 MeV is also observed, but its allocation to the decay of F^{20} is not established. Gamma-gamma coincidence experiments limit the fraction of disintegrations which produce cascade gamma-rays to less than 2%, unless one of the rays has a life-time longer than 10^{-6} sec. A.

539.164 : 539.152.2

2007. Alpha radioactivity and the stability of heavy nuclei. I. PERLMAN. *Nucleonics*, **7**, 3–18 (*Aug.*, 1950).

The detection of alpha-particles and measurement of their energy, particularly the use of ionization chambers and pulse amplitude analysers, is discussed. Observations on alpha-particles may be used to detect and identify isotopes when only a few thousand atoms are present. Regularities between alpha-decay energies, half-lives, nuclear charge and radius are described and energy surfaces are drawn showing mass defect of various alpha-emitters as a function of Z and A. It is pointed out that alpha-decay energies of the different isotopes of a given element decrease with increasing mass number, except in the region of closed shell numbers. The observed half-lives and decay energies of the even-even alpha-active nuclei fall on the curves predicted by the Gamow theory, but other nuclei appear to violate the theory, having half-lives averaging some 10 times too great. There is some evidence to suggest that the ground state transitions are not being observed in many of the latter cases. The prediction of the properties of the alpha-particle emission of heavy isotopes from the observed regularities and properties of neighbouring nuclei have been of great value in detecting isotopes of new elements. The discovery of Cf^{244} is cited as an example. L. R. SHEPHERD

539.164 : 539.155.1/.4

2008. Mass assignments of alpha-active isotopes in the rare-earth region. J. O. RASMUSSEN, F. L. REYNOLDS, S. G. THOMPSON AND A. GHIORSO. Letter in *Phys. Rev.*, **80**, 475–6 (*Nov.* 1, 1950).

539.165

2009. Distributed beta sources in uniformly absorbing media. II. H. H. ROSSI AND R. H. ELLIS, JR. *Nucleonics*, **7**, 19–25 (*Aug.*, 1950).

Calculations of dose and flux for beta sources distributed uniformly in simple geometric shapes which were given in a previous paper [Abstr. 8955 (1950)] are extended to some practical cases. These include the doses above evaporated beta sources of various thicknesses, doses in chick and mouse thyroids due to I^{131}, employing subdivision into spheres and spherical segments, and the minimum dose received at a point inside a cubic lattice of point sources. The last case is applied to the use of P^{32} in the treatment of leukaemia when the P^{32} tends to concentrate in the leukocytes. L. R. SHEPHERD

539.165

2010. The internal conversion of kinetic energy of electrons of beta-active substances. B. BRUNELLI AND G. CUNSOLO. *Nuovo Cim.*, **7**, 847–54 (*Oct.*, 1950) *in Italian.*

In order to decide if the "positive tracks" observed in the Wilson chamber are produced by positive particles coming from the source or by electrons coming from the walls, two sets of photographs have been taken. One set (1 175) was taken with a Ra(B + C) source, contained in a glass holder placed in the middle of the chamber, and the other set (402) without it. Comparing the "positive tracks" (23 compared with 7 790 electrons) to the tracks of the second set (10 tracks) which appeared as positive particles coming from the empty holder, it can be concluded that no positive particles have been observed. A.

539.165

2011. The beta-spectrum of P^{32}. S. D. WARSHAW, J. J. L. CHEN AND G. L. APPLETON. Letter in *Phys. Rev.*, **80**, 288 (*Oct.* 15, 1950).

539.165

2012. The beta-spectrum of sulfur 35 in the range of 0–30 kilovolts. L. GROSS AND D. R. HAMILTON. Letter in *Phys. Rev.*, **80**, 484 (*Nov.* 1, 1950).

539.165.08

2013. Measuring solid samples of low-energy beta emitters. G. K. SCHWEITZER AND B. R. STEIN. *Nucleonics*, **7**, 65–72 (*Sept.*, 1950).

Methods of correcting for self-absorption in the determination of the specific activity of beta-sources, are outlined and compared. These include the use of an equation deduced on the assumption of exponential absorption of beta-particles, a graphical method in which the logarithm of the activity per unit thickness is plotted against source thickness and the resulting straight line extrapolated to zero thickness, and a method due to Aten which involves the use of Al absorbers placed in front of the source. The preparation of thin uniform sources is discussed. L. R. SHEPHERD

539.165.2

2014. The allowed beta-spectrum. C. S. COOK AND G. E. OWEN. *Amer. J. Phys.*, **18**, 453–62 (*Oct.*, 1950).

A short review tracing the development of alternative theories and their experimental verification. At the present time, the experimental evidence strongly supports the Fermi theory for allowed type transitions, and is not in disagreement with it for other types of transition (49 refs.).

539.166

2015. The question of fine structure of the γ-lines of RaC′. G. D. LATYSHEV. Letter in *J. Exp. Theor. Phys.*, **20** (*No.* 2) 192 (1950) *In Russian.*

The claim to have observed fine structure of conversion lines of RaC′, made by the author and collaborators in Abstr. 7252–3 (1949) and 3371 (1950) is now withdrawn [see Abstr. 5241 (1950)]. Experiments with better resolution and 2 μ wall-thickness of ampoule fail to confirm the earlier results, which were invalidated by excessive wall-thickness, inadequate statistics and the fact that the field was not a unique function of the current. The F-line of Th and some RaB lines have also been investigated and show no fine structure. J. C. E. JENNINGS

539.166

2016. Angular correlation of the gamma-rays emitted from the excited states of A^{38}. R. M. STEFFEN. Letter in *Phys. Rev.*, **80**, 115–16 (*Oct.* 1, 1950).

Excited states of 3·75 MeV and 2·15 MeV in A^{38} follow the β-decay of Cl^{38}. Sources of Cl^{38} were obtained by bombarding LiCl with 10 MeV deuterons and the gamma-rays from these sources were observed by means of two scintillation counters using anthracene crystals. A coincidence resolving time of $5{\cdot}8 \times 10^{-8}$ sec was used and an angular resolution of 10° 31′ obtained with the arrangement. Precautions

were taken to avoid spurious coincidences due to Compton scattering from one detector into the other. Test observations were made on the angular correlations of the Ni^{60} γ-rays and Pd^{106} γ-rays and good agreement with the results of Brady and Deutsch obtained. The angular correlation of the A^{38} radiations were found to correspond to the function $f(\theta) = 1 - \frac{1}{2}\cos^4\theta$, characteristic of quadrupole radiation, with $J = 3$, 2, 0 and equal parity for the 3·75 MeV, 2·15 MeV and ground levels respectively.

L. R. SHEPHERD

539.166

2017. Gamma-rays from Ag^{110}. J. M. CORK, W. C. RUTLEDGE, C. E. BRANYAN, A. E. STODDARD, W. J. CHILDS AND J. M. LEBLANC. Letter in *Phys. Rev.*, **80**, 286–7 (*Oct.* 15, 1950).

539.166

2018. Internal conversion of gamma-rays from Co^{60}, Cs^{134}, Zn^{65}. M. A. WAGGONER, M. L. MOON AND A. ROBERTS. *Phys. Rev.*, **80**, 420–8 (*Nov.* 1, 1950).

Using a double-coil, thin-lens magnetic beta-ray spectrometer of transmission 2·40% and line width of approximately 3·0%, the internal conversion coefficients of the gamma-rays from Co^{60}, Cs^{134} and Zn^{65} have been measured. Sufficient precision has been attained in several cases to verify the theoretical values and to obtain unambiguous identification of the multipole character of the gamma-rays. Internal conversion coefficients as small as 10^{-5} can be measured with a precision of 5% or better. The results obtained indicate that both of the gamma-rays from Co^{60} are electric quadrupole (*EQ*), the 560 keV gamma-ray from Cs^{134} is either *EQ* or *MD* or a mixture of these, the 602 and 799 keV gamma-rays from Cs^{134} are both *EQ*, the 1·114 MeV gamma-ray from Zn^{65} is either *EQ* or *MD* or a mixture of these and the 1·363 MeV gamma-ray from Cs^{134} may be *EQ*. Further data on the decay scheme of Cs^{134} are given. The results show that in combination with angular correlation measurements internal conversion data determine the angular momenta and parities of excited nuclear states.

A.

539.166

2019. Internal conversion of gamma-ray from Cs^{137}. M. A. WAGGONER. Letter in *Phys. Rev.*, **80**, 489 (*Nov.* 1, 1950).

539.166 : 537.54

2020. Gamma-ray spectroscopy with crystals of NaI(Tl). R. HOFSTADTER AND J. A. MCINTYRE. *Nucleonics*, **7**, 32–7 (*Sept.*, 1950).

NaI(Tl) contains 85% by weight of I ($A = 53$) and consequently strong lines due to photoelectrons and pairs are present in the secondary electron spectra, thereby facilitating measurement of γ-ray energies. A protective oil film permits these hygroscopic crystals to be kept for weeks in good condition. Observations on the photoelectron line shape in the pulse distribution obtained with 0·411 MeV Au^{198} gamma-rays confirmed that this was Gaussian and corresponded to a value of 1 000 photoelectrons per MeV at the cathode of the photomultiplier employed (an average multiplication of 4 per stage was assumed). Theoretical pulse distributions due to secondary electrons from 0·51, 2·04 and 5·1 MeV γ-rays are calculated on the basis of these figures. Results of measurements on the γ-ray spectra of Na^{24}, Co^{6} Ga^{66} and Au^{198} are given. Spectroscopy is possibl with sources down to 10^{-9} curies.

L. R. SHEPHER

539.166 : 537.5

2021. The measurement of gamma-ray energies wi single crystals of NaI(Tl). R. HOFSTADTER AND J. A MCINTYRE. *Phys. Rev.*, **80**, 631–7 (*Nov.* 15, 1950).

A new method is described for determining gamma ray energies and intensities. The basis of the metho is the observation of narrow pulse distributio (lines) in the scintillations of NaI(Tl). Due to th presence of the I component, pair production and th photoelectric process produce relatively sharp line in the pulse distributions. The Compton proces may also be used in determining gamma-energie Approximate theoretical curves of the pulse distribu tion are shown. Experimental spectra resemble th theoretical patterns, except for differences in intensitie discussed in the text. Electronic as well as photo graphic techniques for obtaining spectra are de scribed. With these methods well-known spectra ar confirmed and new results in the case of Ga^{66} ar given. With a source of less than 10^{-9} curie of K the energy of the gamma-ray has been determined t within 2%. The method described should mak possible a new approach to the study of weak gamma radioactivities and unknown gamma-ray spectra.

539.166 : 539.172

2022. Neutron capture gamma-ray spectra. E HAMERMESH. *Phys. Rev.*, **80**, 415–19 (*Nov.* 1, 1950).

Photographic plates soaked in D_2O may be use for gamma-ray studies. By measuring the ranges o the photo-protons resulting from the photo-disintegra tion of the deuterons in the D_2O, the γ-ray energie can be found. The method is limited to γ-rays o energy above 3 MeV. The neutron-capture γ-ra spectra of Al, Cl, Fe, Br, Cd, La, W, Au and H have been obtained by this method. The resul suggest a possible dependence of the shape of th spectra on the odd-even character of the compoun nucleus.

539.166 : 539.1

2023. The gamma-ray spectrum from the absorptio of π^--mesons in deuterium. L. AAMODT, J. HADLE AND W. PANOFSKY. Letter in *Phys. Rev.*, **80**, 282 (*Oct.* 15, 1950).

539.166.0

2024. Abnormal efficiencies in the scintillation counting of gamma-rays. E. H. BELCHER. Letter *Nature, Lond.*, **166**, 742–3 (*Oct.* 28, 1950).

Abnormally high efficiencies of counting a attributed to multiple counting due to phosphorescen of KI–Tl crystals. Variation of these efficiencies wi γ-ray energy and with counter resolving time studied.

G. F. J. GARLIC

539.166.

2025. The scattering of gamma-rays in extende media. I. Perpendicular incidence on a plane sla L. CAVE, J. CORNER AND R. H. A. LISTON. *Proc. Ro Soc. A*, **204**, 223–59 (*Dec.* 7, 1950).

Various simple theoretical methods have been use No exact solution is available as a test of the methods, but approximations of increasing accurac known to give too small a dose under the slab, ha

been combined with a theoretical upper limit for the dose, forming a zone in which the exact solution must lie. Most of the methods tested could be used even if pair-creation or the photoelectric effect gave an appreciable absorption, though for simplicity the computations have been carried out for pure Compton scattering and for quantum energies of a few MeV. Polarization by the Compton effect has been neglected. The best of the simple methods is a modification of the upper limit solution; in problems where this is too difficult to formulate, a good alternative is to calculate the dose from unscattered and once-scattered quanta, giving the latter the penetrating power of the incident quanta and the maximum possible energy-absorption cross-section. A.

539.166.74

2026. The scattering of gamma-rays in extended media. II. Back-scattering of gamma-rays from a thick slab. J. CORNER AND R. H. A. LISTON. *Proc. Roy. Soc. A*, **204**, 323–9 (*Dec.* 22, 1950).

The dose received by back-scattering at the front face of a thick layer of scattering material irradiated by a uniform beam of gamma-rays has been evaluated for beam directions between normal incidence and glancing incidence, for gamma-ray energies from 250 keV to 3 MeV. Results are given also for a half-slab, which is useful for building up re-entrant angles by superposition, and for a right-angled corner. A.

539.166.74

2027. The scattering of gamma-rays in extended media. III. Problems with spherical symmetry. J. CORNER, F. A. G. DAY AND R. E. WEIR. *Proc. Roy. Soc. A*, **204**, 329–38 (*Dec.* 22, 1950).

Some typical problems of the propagation of gamma-radiation in an extended scattering medium have been solved for pure Compton scattering, which is a good approximation for most materials at gamma-ray energies up to a few MeV. The effects to be expected from air gaps round the source, large source dimensions and plane absorbing materials are demonstrated. A.

539.166.8

2028. Internal pair creation in magnesium-24. W. MIMS, H. HALBAN AND R. WILSON. Letter in *Nature, Lond.*, **166**, 1027–8 (*Dec.* 16, 1950).

The counting of triple coincidences between Na^{24} β-decay and the annihilation radiation of the succeeding positron from internal conversion of the 2·78 MeV γ-ray of Mg^{24} yields conversion coefficient $8{\cdot}25 \pm 1{\cdot}05 \times 10^{-4}$ for this γ-ray, agreeing with theoretical expectation if the γ-ray is electric quadrupole, as other evidence suggests. The positron-detecting efficiency of the arrangement was checked by independent experiments. R. H. DALITZ

539.166.93

2029. The stars initiated by gamma-rays. S. KIKUCHI. Letter in *Phys. Rev.*, **80**, 492 (*Nov.* 1, 1950).

750 stars recorded in Ilford C2 emulsion layers were investigated statistically, determining the number of prongs and their energies by measuring their range or estimating the grain spacing. It is concluded that the stars are unlikely to be produced by π-mesons or neutrons and therefore are probably due to the γ-ray quanta themselves. W. F. BERG

NUCLEAR REACTIONS 539.17

539.172

2030. Structure of the tracks generated by high-energy ionizing particles. P. BUDINI. *Nuovo Cim.*, 7, 835–46 (*Oct.*, 1950) *In Italian.*

The Weizsäcker–Williams method is employed, and the integrated results are compared with those obtained with the Born method. It is found that, as the energy of the particle increases, the distribution of the ions which it generates approaches a limit configuration in which their density is represented by const./p^2, where p is the distance from the axis of the track, and the constant is the integrated photoelectric cross-section of the ionized atoms; it follows that the ions/cm ratio in a track of fixed thickness approaches a fixed value for increasing energy; and if the thickness is comparable with that of the nuclear emulsion, this value is very near to that corresponding to the minimum ionization. The case of tracks in H is treated and that of tracks in other elements discussed. A.

539.172

2031. Decay energy of beryllium-8 nuclei observed in cosmic ray stars. J. CRUSSARD. Letter in *Nature, Lond.*, **166**, 825 (*Nov.* 11, 1950).

539.172.13

2032. Carrier-free radioisotopes from cyclotron targets. XI. Preparation and isolation of Os^{185} and $Re^{183, 184}$ from tungsten. J. D. GILE, W. M. GARRISON AND J. G. HAMILTON. Letter in *J. Chem. Phys.*, **18**, 1419–20 (*Oct.*, 1950).

539.172.13

2033. The $V^{51}(p,n)Cr^{51}$ neutron spectrum. P. H. STELSON, W. M. PRESTON AND C. GOODMAN. Letter in *Phys. Rev.*, **80**, 287 (*Oct.* 15, 1950).

539.172.13

2034. Neutron energy distribution in proton bombardment of beryllium. D. BODANSKY. Letter in *Phys. Rev.*, **80**, 481 (*Nov.* 1, 1950).

539.172.13

2035. Proton-neutron reactions and thresholds. H. T. RICHARDS, R. V. SMITH AND C. P. BROWNE. *Phys. Rev.*, **80**, 524–30 (*Nov.* 15, 1950).

Threshold proton energies for neutron emission have been determined carefully for Be^9, B^{11}, C^{13}, O^{18}, Cl^{37}, K^{41}, V^{51}, Mn^{55}. Thin target yield data up to about 4 MeV proton energy are reported for Be^9, B^{11}, O^{18} and K^{41}. A summary of all reported p–n thresholds for $Z \leqslant 25$ is included. Isobaric mass differences from p–n measurements and from beta-ray end points are compared. Data concerning the suitability of various p–n reactions as controlled energy neutron sources are included. A.

539.172.13

2036. Angular yield of both proton groups from $Li^6(d,p)Li^7$. R. W. KRONE, S. S. HANNA AND D. R. INGLIS. *Phys. Rev.*, **80**, 603–7 (*Nov.* 15, 1950).

The simultaneous measurement of the intensities of two energy groups of product particles is accomplished by sorting out their proportional-counter pulses in an electronic 10-channel discriminator. The angular yields of protons leading to the ground state and to the 480 keV state of Li^7 in the reaction

$Li^6(d, p)Li^7$ have been measured at deuteron energies between 400 and 800 keV. At the higher bombarding energies the angular yields of the two groups are complex and somewhat similar, both containing terms at least as high as $\cos^4\theta$. As the deuteron energy is reduced, the short-range group retains this complexity while the long-range group becomes more nearly spherically symmetric. A.

539.172.13

2037. The emission of short range alpha particles from light elements under proton bombardment. IV. The reaction $^{19}F(p\alpha)^{16}O^*$. J. M. Freeman. *Phil. Mag.*, **41**, 1225–37 (*Dec.*, 1950).

See Abstr. 8984 (1950) for Part III. The short-range alpha particles emitted in the proton bombardment of F have been examined with a magnetic analyser for proton energies from 300 to 950 keV. In the $F^{19}(p\alpha, \gamma)O^{16}$ reaction 3 alpha-particle groups have been measured, the average values of the energy releases being $Q_1 = 1{\cdot}979 \pm 0{\cdot}009$, $Q_2 = 1{\cdot}200 \pm 0{\cdot}010$ and $Q_3 = 0{\cdot}996 \pm 0{\cdot}010$ MeV; the resonances for all 3 groups appear to be the same. The relative intensities of the groups at 6 resonances have been calculated. Angular distribution measurements indicate that there are no large departures from isotropy in the cases examined. Energy measurements of the alpha particles associated with pair emission in the $F^{19}(p\alpha, \pi)O^{16}$ reaction give a value for the energy release of $2{\cdot}056 \pm 0{\cdot}012$ MeV. A.

539.172.13 : 539.185

2038. Neutron production by proton bombardment below the (p,n) threshold. B. Jennings, K. H. Sun and H. A. Leiter. Letter in *Phys. Rev.*, **80**, 109–10 (*Oct.* 1, 1950).

539.172.13

2039. Angular distribution of the $Al^{27}(d, \alpha)Mg^{25}$ reaction and energy levels in Mg^{25}. A. D. Schelberg, M. B. Sampson and R. G. Cochran. *Phys. Rev.*, **80**, 574–9 (*Nov.* 15, 1950).

The energy distribution and angular dependence of the alpha-particle groups from the nuclear reaction $Al^{27}(d, \alpha)Mg^{25}$ have been investigated. A magnetically analysed beam of 11·1 MeV deuterons was used. Eleven alpha-particle groups were measured, corresponding to ten excited levels in Mg^{25} at 0·57, 0·96, 1·63, 1·97, 2·74, 3·36, 4·01, 4·81, 5·48 and 5·95 MeV. The ground state Q-value for the reaction was found to be $6{\cdot}58 \pm 0{\cdot}03$ MeV, giving a value for the mass difference Al^{27}–Mg^{25} of $1{\cdot}99626 \pm 0{\cdot}00003$ mass units. The intensities of all the groups, with the exception of Q_2, show marked dependence on the angle of measurement. The average spacing of the levels in Mg^{25} is 0·6 MeV, and is nearly constant over the range studied. A.

539.172.13

2040. Protons from the deuteron bombardment of enriched silicon and related atomic masses. H. T. Motz and R. F. Humphreys. *Phys. Rev.*, **80**, 595–602 (*Nov.* 15, 1950).

Enriched samples of silicon have been bombarded with 3·8 MeV deuterons and 17 proton groups have been assigned to the $Si^{28}(d, p)Si^{29}$, $Si^{29}(d, p)Si^{30}$ and $Si^{30}(d, p)Si^{31}$ reactions. The ground state transitions for $Si^{28}(d, p)Si^{29}$ and $Si^{29}(d, p)Si^{30}$ are found to be $6{\cdot}18 \pm 0{\cdot}09$ MeV and $8{\cdot}36 \pm 0{\cdot}10$ MeV. Seven proton groups corresponding to excited states in Si^{29} and three groups leading to excited states in Si^{30} have been observed. Five groups are found to be associated with $Si^{30}(d, p)Si^{31}$, with a sixth in doubt. A method for using extrapolated range measurements to obtain mean ranges is described. The published transition energies of reactions possibly involving ground states of Al, Si and P isotopes are tabulated. These energies are converted to mass differences which are presented on a diagram. The lack of satisfactory consistency of these mass differences is discussed and the discrepancy of reaction data and mass spectroscopic data between Al and S is outlined. A.

539.172.13

2041. Deuteron bombardment of C^{14}. E. L. Hudspeth, C. P. Swann and N. P. Heydenburg. *Phys. Rev.*, **80**, 643–6 (*Nov.* 15, 1950).

Bombardments of C^{14} by deuterons produces 3 nuclear reactions, yielding neutrons, α-particles and protons, and leads thereby to the formation of N^{15}, B^{12} and a new radioactive isotope, C^{15}. The half-life of the 6th isotope of carbon is 2·4 sec, and the end-point of the β-ray spectrum lies at 8·8 MeV. Approximate values for relative yields from the various reactions are given, the neutron spectrum is obtained, and the nature of the γ-rays emitted during bombardment is reported. A.

539.172.13

2042. Experiments on the reaction $T(d, n)^4He$. I. The 90° cross-section. D. L. Allan and M. J. Poole. *Proc. Roy. Soc. A*, **204**, 488–99 (*Jan.* 9, 1951).

The 90° cross-section of the reaction $H^3(d, n)He^4$ has been investigated over the energy range 100 to 200 keV (energy of bombarding triton) using the 200 keV accelerating set of the establishment. Two methods have been used. As a preliminary experiment the yield of alpha-particles from a thick heavy-ice target was measured per unit charge of incident beam, as a function of deuteron energy, and the variation of cross-section deduced from the gradient of this excitation curve and the range-energy relation for tritons in heavy water. Secondly, a comparison was made between the yield of alpha-particles from the D–T reaction and the yield of protons from the D–D reaction when a beam containing both deuterons and tritons was passed through a heavy-water vapour target. (The energy loss in this target was calculated as only a few hundred electron volts.) To do this a simultaneous observation was made of the protons and alpha-particles using the same counter. The values obtained for the cross-section have been compared with the resonance formulae given by Bretscher and French (1949) and by Taschek, Everhart, Gittings, Hemmendinger and Jarvis (1948) and have been found to be in disagreement with formulae of this type. From considerations of the absolute magnitude of the cross-section it has been deduced that no conventional theory postulating reaction at a distance equal to the sum of the nuclear radii (cf. Konopinski and Teller, 1948) will be able to explain this reaction.

The evidence for a low-energy resonance (Allan and Poole, 1949) is thought to be inconclusive. A.

539.172.13

2043. Experiments on the reaction $T(d, n)^4He$. II. The angular distribution. D. L. Allan and M. J. Poole. *Proc. Roy. Soc. A*, **204**, 500–2 (*Jan.* 9, 1951).

A measurement of the angular distribution of α-particles from the T–D reaction has been made by bombarding a heavy-water vapour target with a beam of tritons. Observations were made at three triton energies, 125, 175 and 200 keV, but only with high statistical accuracy at 175 keV. In all cases the disintegration was found to take place symmetrically in centre of mass space within the limits of experimental error. A.

539.172.3

2044. Photo-disintegration of O^{16}. M. A. Preston. Letter in *Phys. Rev.*, **80**, 307–8 (*Oct.* 15, 1950).

539.172.3

2045. Photo-neutron thresholds of beryllium and deuterium. R. C. Mobley and R. A. Laubenstein. *Phys. Rev.*, **80**, 309–14 (*Nov.* 1, 1950).

These have been measured by comparison with the $Li^7(p, n)$ threshold. For this purpose an electrostatic generator was used in which an electron beam and a positive ion beam were established simultaneously. Accurate control and measurement of the generator voltage was obtained by using an electrostatic analyser on the H_2^+ component of the ion beam. Because the $Li^7(p, n)$ threshold lies between the $Be^9(\gamma, n)$ and $D(\gamma, n)$ thresholds, errors in extrapolation should be small. The electron beam was accelerated from ground to the accurately known potential of the high voltage electrode where X-rays were produced for the photo-disintegration process. From the photo-neutron thresholds the neutron binding energies of Be and D were found to be $1{\cdot}666 \pm 0{\cdot}002$ and $2{\cdot}226 \pm 0{\cdot}003$ MeV respectively. A.

539.172.3

2046. Photo-disintegration of the deuteron. J. A. Phillips, J. S. Lawson, Jr. and P. G. Kruger. *Phys. Rev.*, **80**, 326–31 (*Nov.* 1, 1950).

A study, using a cloud chamber as a detector, has been made for gamma-ray energies of 6·14 and 7·00 MeV from the $F(p, \alpha)O^{16*}$ reaction. By observing the number of photo-disintegration protons and the number of electron pairs formed in the gas (CD_4) of the cloud chamber, the ratio of the photo-disintegration cross-section to the pair cross-section is obtained. Assuming a calculated value for the pair cross-section these data yield $\sigma[D(\gamma, p)n] = 25{\cdot}7$ (14% P.E.) $\times 10^{-28}$ cm^2 at an average gamma-ray energy of 6·55 MeV. A plot of the angular distribution of the photo-disintegration protons agrees, within statistical limits, with $\sin^2\theta$, though there may be a slight asymmetry in the forward direction. A.

539.172.3

2047. Photo-disintegration of silver and aluminum. B. C. Diven and G. M. Almy. *Phys. Rev.*, **80**, 407–14 (*Nov.* 1, 1950).

The energy and angular distributions of protons emitted from Ag and Al nuclei when irradiated with the X-rays from a 22 MeV betatron were determined with the use of photographic nuclear emulsions. A maximum X-ray energy of 20·8 MeV was used with Ag and energies of 20·8, 17·1 and 13·9 MeV with Al. With Ag the number of neutrons emitted in the same irradiations was determined from the (γ, n) induced activity. The ratio of numbers of protons in each MeV interval to the total number of neutrons is compared to the same ratio calculated on the basis of various assumptions as to level density and nuclear-reaction cross-sections. The comparison suggests that the observed proton spectrum consists of two overlapping components. One is a lower energy group in rough quantitative agreement as to spectrum shape and numbers with calculations from reasonable assumptions as to statistical-model level densities and other nuclear parameters. The second group is a high energy tail (10–14 MeV) of protons definitely outside the spectrum expected from the statistical model. Moreover, only the high-energy group shows angular asymmetry with a preference for emission at 90° to the X-ray beam, which supports the hypothesis that these protons are emitted before the excitation energy is statistically distributed in the nucleus. The ratio of total numbers of protons to neutrons emitted by Ag under 20·8 MeV bremsstrahlung radiation is $0{\cdot}023 \pm 0{\cdot}008$. With Al protons are emitted with spherical symmetry and with a yield, for quanta above about 14 MeV, as large or larger than the (γ, n) yield determined by Hirzel and Wäffler at 17·6 MeV. The shape of the spectrum and the ratio of (γ, p) to (γ, n) cross-sections are compatible with the assumption of a constant or slowly increasing level density in the residual nucleus, as expected for a light nucleus in the energy range involved. From the maximum energy of emitted protons the proton threshold was determined to be $8{\cdot}6 \pm 0{\cdot}5$ MeV. For use with the theoretical calculation of the proton spectra, the (γ, n) cross-sections as a function of X-ray quantum energy were determined for $Ag^{107, 109}$, Al^{27} and also for Cu^{63}. The cross-section of Ag^{109} was found to have a maximum of $0{\cdot}32 \times 10^{-24}$ cm^2 at 16·5 MeV, Cu^{63} a maximum of $0{\cdot}10 \times 10^{-24}$ cm^2 at 17·5 MeV. For Al^{27} the cross-section is still rising at 22 MeV. A.

539.172.3

2048. Photo-disintegration cross sections of deuterium and beryllium for the gamma-rays of sodium 24 and gallium 72. A. H. Snell, E. C. Barker and R. L. Sternberg. *Phys. Rev.*, **80**, 637–42 (*Nov.* 15, 1950).

Photo-neutron yields from spheres of D_2O and Be containing Na^{24} and Ga^{72} gamma-ray sources were measured by spatial integration of induced foil activities in a large paraffin block. A standard neutron source was used to calibrate the apparatus. The Ga^{72} and Na^{24} sources were subsequently dissolved, and their radioactive strengths were measured by beta-counting of aliquots. The data so obtained, when combined with the known wall thickness of the spheres, led to the following results after the application of appropriate corrections: photo-disintegration cross-section of D at 2·76 MeV: $14{\cdot}3 \times 10^{-28}$ cm^2; of Be at 2·76 MeV: $6{\cdot}74 \times 10^{-28}$ cm^2; cross-section of D at 2·50 MeV $\times$ intensity of 2·50 MeV line in quanta per Ga^{72} beta-emission: $2{\cdot}81 \times 10^{-28}$ cm^2; sum of cross-

sections of Be at 1·84, 2·20 and 2·50 MeV weighted according to respective gamma-intensities in Ga^{72}: $2{\cdot}16\times10^{-28}$ cm². These results are believed accurate within 8%. Agreement with theory is discussed for both D and Be. A.

539.172.4

2049. The relative neutron capture cross sections of the isotopes of krypton and xenon. J. MACNAMARA AND H. G. THODE. Letter in *Phys. Rev.*, **80**, 296–7 (*Oct.* 15, 1950).

539.172.4

2050. Protons and deuterons ejected from nuclei by 90-Mev neutrons. J. HADLEY AND H. YORK. *Phys. Rev.*, **80**, 345–54 (*Nov.* 1, 1950).

The angular and energy distributions of the fast charged particles emerging from nuclei bombarded by 90 MeV neutrons have been investigated. The results indicate that the nature of the collision process is determined predominantly by interactions of the bombarding particle with single nucleons rather than with the struck nucleus as a whole; angular distributions are found to be peaked in the forward direction for all emergent particles, the degree of peaking increasing with energy. Deuterons are found to be more concentrated in the forward direction than are protons. In the case of C, particles travelling in the forward direction with energies greater than 20 MeV consist of 60% protons, 36% deuterons and about 4% tritons. A.

539.172.4

2051. Disintegration of He^3 by fast neutrons. J. H. COON. Letter in *Phys. Rev.*, **80**, 488 (*Nov.* 1, 1950).

539.172.4

2052. Slow neutron cross-sections of molybdenum and bromine. P. A. EGELSTAFF AND B. T. TAYLOR. Letter in *Nature, Lond.*, **166**, 825–6 (*Nov.* 11, 1950).

539.172.4

2053. Resonance capture of neutrons by uranium. H. L. ANDERSON. *Phys. Rev.*, **80**, 499–506 (*Nov.* 15, 1950).

The resonance capture of slow neutrons by U^{238} has been studied by absorption methods with "good" geometry and thin detectors using the cyclotron as an intense source of neutrons. The experimental cross-section for self-absorption for slow neutrons transmitted by Cd was measured with thin absorbers and found to be $4\,600\times10^{-24}$ cm²/atom ± 40%. Evidence is given for the existence of more than one level. The predominant level has an energy somewhat under 11 eV, a total natural width somewhat less than 0·20 eV and a neutron width somewhat less than 0·0086 eV. The value $\int\sigma dE/E$ in the resonance region was found to be 290×10^{-24} cm²/atom ± 40%. A.

539.172.4

2054. The disintegration of boron by slow neutrons. G. C. HANNA. *Phys. Rev.*, **80**, 530–4 (*Nov.* 15, 1950).

The total ionization produced by the Li^7 and α-particles from the $B^{10}(n,\alpha)Li^7$ reaction has been measured in an argon/boron-trifluoride gas mixture, and that produced by the two particles separately with a thin boron film. Electron collection has been employed, using a fast amplifier feeding a 30-channel pulse-analyser. The results indicate a departure from linearity in the relation between ionization and energ Using the formula suggested by Cranshaw and Harv in their work on natural α-emitters, values of the of the boron reaction have been obtained. They a 2·793 ± 0·027 MeV and 2·320 ± 0·020 MeV for t ground state and excited state transitions, in agre ment with the recently published values of Tollestru Fowler and Lauritsen. The branching ratio, that the probability of the reaction going to the grou state, has been measured as 5·8 ± 0·1%.

539.172

2055. The disintegration of the deuteron by neutr impact. B. H. BRANSDEN AND E. H. S. BURHO *Proc. Phys. Soc., Lond. A*, **63**, 1337–48 (*Dec.*, 1950)

The method of distorted waves is applied co sistently to the calculation of the cross-section f disintegration of deuterons by neutrons. At a incident neutron energy of 11·5 MeV the cross-sectio calculated for the process ($6{\cdot}4\times10^{-25}$ cm²) is abou one-third that obtained in previous calculations b is, nevertheless, an order of magnitude greater tha that indicated by the rather meagre experimental dat The calculated cross-section is also larger than th maximum permitted by considerations of the co servation laws. This indicates that the *n–d* interactio is so strong that the requirements for the validity the distorted wave method are not satisfied. At a incident neutron energy of 5·1 MeV, where it considerably less than the permitted maximum, th calculated cross-section is of the same order magnitude as that deduced indirectly from measur ments of the *p–d* disintegration cross-section, allowin for the effects of the electrostatic repulsion betwee the proton and the deuteron.

539.172.

2056. A survey of ceramics for nuclear reactor R. F. GELLER. *Nucleonics*, **7**, 3–17 (*Oct.*, 1950).

The relative merits of a number of ceramics possible use in nuclear reactors are discussed. Th most important properties, including melting point thermal expansion coefficients, elastic moduli, density strength and hardness as well as nuclear propertie such as thermal neutron capture cross-sections an slowing-down powers, are tabulated. L. R. SHEPHER

539.172.

2057. What are the prospects for industrial nuclea power? E. AYRES AND C. A. THOMAS. *Nucleonics* **7**, 72–8 (*Aug.*, 1950).—A general review.

539.172.

2058. Energy barrier for asymmetric fission in th static liquid drop model. J. JUNGERMAN. Letter i *Phys. Rev.*, **80**, 285–6 (*Oct.* 15, 1950).

The fission barrier of U^{236} is calculated for tw different liquid drop models, the first consisting o two tangent spheres: (*a*) with equal radii, (*b*) wit radii in the ratio 7 to 8, joined by the frustrum of a cone tangential to each sphere. A distorted ellipsoid was adopted in the second model. In both cases the energy barrier against asymmetric fission was found to be greater than for the symmetric case.

L. R. SHEPHERD

539.172.

2059. Ionization defects of fission fragments. J. K KNIPP, R. B. LEACHMAN AND R. C. LING. Letter i *Phys. Rev.*, **80**, 478 (*Nov.* 1, 1950).

TOM AND MOLECULE BEAMS . MESONS NEUTRONS 539.18

539.18

060. Production of positive mesons by photons on ydrogen. A. S. BISHOP, J. STEINBERGER AND L. J. OOK. Letter in *Phys. Rev.*, **80**, 291 (*Oct.* 15, 1950).

539.18

061. On the μ-meson decay. G. G. HARRIS AND . J. B. SHANLEY. Letter in *Phys. Rev.*, **80**, 474 *Nov.* 1, 1950).

539.18 : 537.531

062. Production of μ^+-mesons by X-rays as a nction of atomic number. R. F. MOZLEY. Letter in *hys. Rev.*, **80**, 493–4 (*Nov.* 1, 1950).

539.181.2

063. Photon production of mesons. G. MORPURGO. *Iuovo Cim.*, **7**, 855–67 (*Oct.*, 1950) *In Italian.*

In connection with the Berkeley experiments, the ifferential cross-section for the process has been alculated in the first approximation (e.g.) of per-rbation theory; use has been made of the pseudo-calar theory with pseudoscalar coupling and scalar neory with scalar coupling. In contrast with past ork the recoil of nucleons has also been taken into ccount: this is shown to be always essential for high nergies of the impinging photon; moreover, it is ssential also for low energies of the photon in the seudoscalar theory. In particular, the ratio between ne numbers of positive and negative mesons emitted examined; both by pseudoscalar theory (as already stablished) and scalar theory this ratio is the same nd in good agreement with experiment; the differential oss-sections themselves are, however, different in e two theories. For high energies ($\gg M$) of the noton the ratio negative to positive is of the order nity at 0° (with respect to the direction of the npinging photon), but varies very rapidly with the ngle. For example, for an energy of the photon of) GeV and angle of 90° this ratio is ~ 120. However, e ratio between the total cross-sections for the oduction of a negative and a positive meson is ~ 2. A.

539.185

064. The theoretical behaviour of a magnetic onopole in a Wilson cloud chamber. H. J. D. COLE. *oc. Camb. Phil. Soc.*, **47** (*Pt* 1) 196–206 (1951).

Dirac has suggested that the quantization of electric arge could be explained by the existence of magnetic onopoles. In view of this hypothesis, this paper vestigates what theoretically would be the behaviour such monopoles in a Wilson cloud chamber. The atment, which for simplicity is basically classical, sely follows Bohr's work on the decrease of velocity d ionization properties of α- and β-particles, and pressions are derived for the rate of decrease of ergy and the number of ion-pairs produced per ntimetre by a monopole passing through a gas. ese expressions are then discussed with particular erence to the case of heavy particles, and the main ferences between them and the corresponding pressions for α-particles both as to range and ization are indicated; these differences can be mmarized by saying that monopoles have much rter paths, but create many more ion-pairs per centimetre than α-particles. Also, the very sharp increase in the ionization at the end of the path of an electric particle is missing, the ionization for the monopole decreasing to a small amount near the end of the path. A.

539.185

2065. Determination of the strength of a neutron source. A. BRACCI, U. FACCHINI AND E. GERMAGNOLI. *Nuovo Cim.*, **7**, 881–91 (*Oct.*, 1950) *In Italian.*

The distribution curve in water of Raα + Be neutrons has been determined by means of thin In foils. In order to evaluate the absolute strength of the source (501·87 mg of Ra), the yield of the counting system has been measured by irradiating the same detectors by a thermal neutron flux of known intensity. The source strength has been found to be $3{\cdot}01 \pm 0{\cdot}15 \times 10^6$ neutrons sec^{-1}. A.

539.185

2066. The effect of the mean free path of fast neutrons on the distribution of thermal neutrons in multiplying media. S. GALLONE AND C. SALVETTI. Letter in *Nuovo Cim.*, **7**, 901–2 (*Oct.*, 1950) *In Italian.*

Calculations are carried out for a particular distribution function. The effect produces only slight modifications to the results given in previous papers [see Abstr. 9015 (1950), 645 (1951)]. L. PINCHERLE

539.185

2067. Spin dependence of neutron scattering by Na^{23}. W. SELOVE. Letter in *Phys. Rev.*, **80**, 290 (*Oct.* 15, 1950).

It is concluded from resonance experiments that the "potential scattering" of Na^{23} for slow neutrons is strongly spin-dependent. The cross-sections for the two spin states are given as 0·8 barn and 8·8 barns approximately. Statistical spin factors are not included. J. THEWLIS

539.185

2068. On the angular distribution of 3·1-Mev neutrons scattered by protons. Y. ODA, J. SANADA AND S. YAMABE. Letter in *Phys. Rev.*, **80**, 469 (*Nov.* 1, 1950).

539.185

2069. Scattering and polarization of neutrons in an iron single crystal. D. J. HUGHES, M. T. BURGY AND W. E. WOOLF. Letter in *Phys. Rev.*, **80**, 481–2 (*Nov.* 1, 1950).

539.185

2070. Small angle scattering of thermal neutrons. H. H. A. KRUEGER, D. MENEGHETTI, G. R. RINGO AND L. WINSBERG. *Phys. Rev.*, **80**, 507–10 (*Nov.* 15, 1950).

Experiments on the small-angle scattering of thermal neutrons by powders are compared with theory. The available theories, which closely resemble those for small-angle scattering of X-rays, are found to give a satisfactory account of the results. In general, the neutrons are scattered into a Gaussian distribution in angle whose width is directly proportional to the wavelength of the neutrons, the coherent scattering amplitude of the nuclei in the powder and the square root of the number of particles traversed in the powder by any one neutron. A.

539.185

2071. Neutron refraction in ferromagnets. M. Lax. Letter in *Phys. Rev.*, **80**, 299 (*Oct.* 15, 1950).

Reconciles mathematically the views of Halpern and Ekstein, using a general theory of multiple scattering. The theory suggests that the index of refraction is determined by the forward scattering amplitude, that the Born approximation to the magnetic forward scattered amplitude vanishes, and that the change in refractive index does not vanish but is determined by the magnetic field in the magnet.

J. THEWLIS

539.185.08

2072. Some mechanical features of a double-crystal neutron spectrometer. G. E. Bacon, J. A. G. Smith and C. D. Whitehead. *J. Sci. Instrum.*, **27**, 330–1 (*Dec.*, 1950).

A description is given of the mechanical design of a mobile instrument for use with an atomic pile. The two crystal tables and counter arm can be rotated either by hand or electrically, from a remote point if necessary. Angular positions, determined by divided glass circles, can be read to an accuracy of a minute of arc and are displayed on an illuminated screen. Provision is made for automatic operation.

A.

539.185.7

2073. Pile neutron absorption cross sections. S. P. Harris, C. O. Muehlhause, S. Rasmussen, H. P. Schroeder and G. E. Thomas. *Phys. Rev.*, **80**, 342–4 (*Nov.* 1, 1950).

Neutron absorption cross-sections for over 50 elements have been measured in the neutron flux of the Argonne heavy water reactor. Measurements were made by observing the oscillating component of reactor power as a neutron absorber sample was oscillated in and out of the central flux of the pile. Calibration was effected with B.

A.

STRUCTURE OF SOLIDS 539.2

539.2

2074. Processes of germination in solid solutions. P. Laurent. *Rev. Métall.*, **47**, 835–42 (*Nov.*, 1950) *In French.*

A critical review of the statistical theories of phase transformations in metals. 22 refs.

H. P. MYERS

539.211 : 548.0

2075. Influence of optical working on surface structure of plastic crystals. A. Smakula and M. W. Klein. *J. Opt. Soc. Amer.*, **40**, 748–50 (*Nov.*, 1950).

Single crystals of thallium bromoiodide show domains with inclination angles up to 6°. Fast cutting or thermal shock introduces cracks along the glide planes (110). Turning on a lathe or shaping tears the material from the surface in the form of chips if the cutter moves against the glide plane. Grinding develops flow lines under the surface which have to be removed by proper annealing before final polishing. Precisely shaped surfaces without polishing show good i.r. transmission beyond 2 microns. Plates with rough shaped surfaces show a low tra mission at short wavelengths and high transmissi at long wavelengths. They may find application filters for the reduction of stray light in i.r. spect photometers.

539.2

2076. On the structure of Na_2O–SiO_2 glasses. Yokota. *J. Phys. Soc. Japan*, **5**, 354–6 (*Sept.–O* 1950).

If, in the mixture $(Na_2O)_x(SiO_2)_{1-x}$, we def $N_{Si} = (1 - x)/(2 - x)$ then rapid changes in cert properties frequently occur at values of N_{Si} cor sponding to definite compounds. In particular, $N_{Si} = 0{\cdot}40$, $0{\cdot}435$ corresponding respectively $Na_2O\,.\,2SiO_2$ and $3Na_2O\,.\,10SiO_2$, Warren a Biscoe's X-ray data can be used to show such chan qualitatively. A new suggestion to account for th results (together with viscosity measurements) is t in the neighbourhood of $N_{Si} = 0{\cdot}40$ the local str ture is like mica with silica sheets bonded by Na ato

R. O. DAV

539.2

2077. Surface energy and structure of crystal bo daries in metals. K. T. Aust and B. Chalme *Proc. Roy. Soc. A*, **204**, 359–66 (*Dec.* 22, 1950).

The variation of boundary energy γ_R in Pb with difference of orientation θ was determined using methods previously described for Sn. It was fou that the energy decreases progressively as the dif ence of orientation decreases below about 16°. T curve relating energy with difference of orientati extrapolates to zero energy at zero angle. Th results agree qualitatively with those of Sn and o further strong support for the "transitional latti theory of the crystal boundary. Straight-line pl of log θ against γ_R/θ were obtained for Pb and S These results are closely consistent with Shockley a Read's theoretical predictions based on a dislocati model of the transition boundary.

539.2

2078. Grain boundaries and sintering. A. Greenough. Letter in *Nature, Lond.*, **166**, 90 (*Nov.* 25, 1950).

As a specimen of cold-rolled Ag sheet is annea at 900°c the blow-holes (originally small and uniform distributed) become larger and mostly concentrated the grain boundaries. The change is in accorda with classical thermodynamics. In investigations sintering it is usual to assume a uniform distributi of pores throughout; this assumption is therefore n always justified.

N. CORCOR

539.2

2079. Investigation of zinc diffusion in silver-z alloys with admixtures. M. Butsyk and S. Ge sriken. *J. Tech. Phys., USSR*, **20**, 428–30 (*Ap* 1950) *In Russian.*

The diffusion coefficients, activation energy a entropy of activation, S, of the zinc in the allo Ag–Zn, Ag–Zn–Au, Ag–Zn–Ga, Ag–Zn–Sn, Ag–Z Sb, Ag–Zn–Al, Ag–Zn–In were determined. It w shown that there is a linear dependence of the var tion of the activation energy ΔE and the variation the activation entropy $\delta(\Delta S)$ on the valency of

third element. When the valency of the third element changes, $\delta(\Delta S)$ becomes a linear function of its atomic number. B. F. KRAUS

539.217

2080. The mechanism of self-diffusion in alkali metals. H. R. PANETH. *Phys. Rev.*, **80**, 708–11 (*Nov.* 15, 1950).

On the basis of calculations of the activation energies of various ring, vacancy, and interstitial mechanisms in alkali metals, the most probable mechanism of self-diffusion is found to be the rapid transmission of short linear regions of compression (referred to as "crowdions") along body-diagonals in the body-centred cubic lattice. The creation of crowdions, which can be regarded as interstitial atoms diluted over a region of about 8 interatomic distances in a vernier-like fashion, occurs at the surface rather than in the interior of a perfect lattice. The calculation of the corresponding energy of formation depends on the empirical values for the work function, heat of sublimation and ionization energy; for Na, the total heat of activation for diffusion by crowdions is probably less than $\frac{1}{10}$ eV. A.

539.217

2081. Diffusion of copper along the grain boundaries of nickel. R. S. BARNES. Letter in *Nature, Lond.*, **166**, 1032 (*Dec.* 16, 1950).

Using carefully purified metals, Cu is found to diffuse more rapidly along the grain boundaries of the central Ni than through the grains themselves. Twin boundaries do not affect the result. Microphotographs show that the rate of diffusion is between 1·5 and 4 times that in the grains. N. CORCORAN

539.217

2082. Measurements on the diffusion of interstitial atoms in B.C.C. lattices. C. A. WERT. Letter in *J. Appl. Phys.*, **21**, 1196–7 (*Nov.*, 1950).

The diffusion coefficients of N in α-Fe and of C in Ta and Cb have been determined by measurements of the internal friction and elastic after-effect in the temperature range 250°–400°K. The coefficient is shown to obey the relation $D = D_0 \exp(-H/RT)$. The results, together with those of other workers, are examined in the light of the suggestions of Wert and Zener [Abstr. 3420 (1950)] concerning the dependence of D_0 on the geometrical constants of the lattice and the physical properties of the solute atom. H. P. MYERS

539.234

2083. A 72-inch high vacuum evaporator and its glow discharge equipment. N. C. BENSON, G. HASS AND N. W. SCOTT. *J. Opt. Soc. Amer.*, **40**, 687–90 (*Oct.*, 1950).

Constructed primarily for applying silicon monoxide-protected Al coatings to 60 in searchlight reflectors. Data are presented on studies made to determine the optimum shape, size and position of glow discharge cathode for obtaining uniform heating and consequent cleaning of mirror forms. The experience gained from the studies made on glow discharge arrangements for the 72 in evaporator was used in designing discharge arrangements for small coaters. A.

539.264

2084. The structure of lead sulfide films. J. A. JAMES, C. J. MILNER AND B. N. WATTS. Letter in *Phys. Rev.*, **80**, 298 (*Oct.* 15, 1950).

539.27

2085. An electron diffraction study of structures of tetramethylorthosilicate, hexamethyldisiloxane, and hexachlorodisiloxane. K. YAMASAKI, A. KOTERA, M. YOKOI AND Y. UEDA. Letter in *J. Chem. Phys.*, **18**, 1414–15 (*Oct.*, 1950).

539.27

2086. Electron diffraction study of the order-disorder transformation of the $AuCu_3$ alloy. H. RAETHER. Note in *Acta. Cryst.*, **4**, 70–1 (*Jan.*, 1951) *In French.*

ELASTICITY . STRENGTH . RHEOLOGY 539.3/.8

539.31

2087. Approximate theory of the high-elastic deformation of rubber. G. M. BARTENEV. *J. Tech. Phys., USSR*, **20**, 461–71 (*April*, 1950) *In Russian.*

The deformation of rubber may be regarded as a phenomenon of "mechanical polarization." The analogy between electric and mechanical polarization does not, however, come out completely owing to the 3-dimensional structure of the rubber and the structure of the macromolecules. An approximate deformation law, satisfactorily representing the experimental facts in the whole range of tests, is given for the case of 1-dimensional tensile stressing of rubber specimens. Wall's [Abstr. 2869 (1942)] and Guth's [Abstr. 1414 (1941)] formula cannot be applied to the rubbers tested. Proportionality between stress and strain was found to exist for rubber within wide limits. This is in agreement with the theory presented as well as with the experiments. The limit of proportionality lies at about 40 kg/cm². Below this the stress in constant deformation is directly proportional to the absolute temperature, whereas above this limit the temperature relation of the stress has a more involved character. B. F. KRAUS

539.32

2088. High-elasticity characteristics of non-crystallized rubber. G. M. BARTENEV AND L. A. VISHNITSKAYA. *J. Tech. Phys., USSR*, **20** (*No.* 7) 858–65 (1950) *In Russian.*

A method of obtaining equilibrium curves in tensile stressing is presented, based on measurements of butadiene-styrol rubber. The theory of the high-elastic deformation is compared with the experimental data. Vulcanizates of butadiene-styrol rubber obey, within wide limits ($\lambda = 1$ to $\lambda = 5$) of tensile stressing, a linear law of deformation (Bartenev's formula), $\sigma = E_\infty(\lambda - 1)$ Wall's formula is correct only up to about 60% tensile deformation; here the two theories agree. Thus the calculation of the number of molecular chains per unit volume of rubber is possible by the simplest formula $N = E_\infty/3kT$. The character of the dependence of the elastic modulus E_∞ on vulcanization time agrees with results previously obtained in 2-dimensional deformation of butadiene-styrol rubber. B F. KRAUS

539.32

2089. Variation of the elastic modulus in torsion. N. N. DAVIDENKOV, I. S. ZHAKOVSKAYA AND V. A. ZHURAVLEV. *J. Tech. Phys., USSR*, **20**, 534–42 (*May*, 1950) *In Russian.*

539.32

2090. The vibrational properties of wood. E. FUKADA. *J. Phys. Soc. Japan*, **5**, 321–7 (*Sept.–Oct.*, 1950).

Lateral vibrations of a rectangular bar of airdried wood (20 cm × 2 cm × 0·5 cm) with pieces of iron attached at the ends were excited electromagnetically. The oscillating bar induces an alternating current in a pickup coil, which is amplified, rectified and measured on a microammeter. Young's modulus was determined from the resonance frequency. The log. dec. was found from the total rectified charge flowing in the pick-up circuit. This charge was determined ballistically after switching off the exciting voltage. A correction is applied for the finite time of switching. Each mode in the frequency range 100–5 000 c.p.s. was determined. 28 samples of wood were tested and classified by the log. dec./frequency curves.

J. E. CAFFYN

539.32 : 534.13 : 548.0

Elastic compliances of ammonium arsenate. *See Abstr.* 2157

539.32 : 539.67

2091. On the Young's moduli and the internal friction of papers. H. KAWAI AND N. TOKITA. *J. Phys. Soc. Japan*, **5**, 365–9 (*Sept.–Oct.*, 1950).

The effect of humidity, amplitude and frequency on the modulus and internal friction were investigated. From considerations of the energy required to move a portion of a fibre clamped at each end, the internal friction is shown to be independent of amplitude whilst a modified Voigt model is proposed when it depends on amplitude. J. E. CAFFYN

539.37

2092. Finite elastic straining. K. H. SWAINGER. *Appl. Sci. Res.*, **A2** (*No.* 4) 281–98 (1950).

Finite elastic straining is analysed with all quantities referred consistently to the deformed body taken as the function domain. The straining-displacement of a typical point is relative to a set of axes imbedded in the body at one arbitrary point and rotating in fixed space with that neighbourhood if necessary in a particular problem. The resulting plane stress equations have precisely the same form as in the classical theory but relate to true quantities in the deformed body. Any boundary value problem already solved for the classical infinitesimal strains theory can be applied directly as a finite strains solution for the deformed body. A.

539.373

2093. On the critical load of a disk compressed beyond the elastic limit. P. CICALA. *Atti. Accad. Naz. Lincei* (*R.C. Cl. Sci. Fis. Mat. Nat.*) **9**, 67–71 (*July–Aug.*, 1950) *In Italian.*

An investigation of the forms of equilibrium that obtain when a strip of material supported on its 4 sides and free in the centre is being compressed lengthwise. The mathematical analysis permits the conclusion that the load which begins to deform the plate transversely, when calculated on the basis of th Batdorf–Budiansky theory, agrees with the exper mental values; and that, while the deformation of th plate grows, the resistance of the plate increas without, however, reaching the value of the incr mental theory. W. SUMME

539.3

2094. The forces exerted on dislocations and th stress fields produced by them. M. PEACH AND J. KOEHLER. *Phys. Rev.*, **80**, 436–9 (*Nov.* 1, 1950).

It is shown that the force $d\mathbf{F}$ exerted on a line el ment $\nu d\sigma$ of a dislocation with Burger's vector $\mathbf{f}$ by stress τ is given by $d\mathbf{F} = -\nu \times (\mathbf{f} \cdot \tau) d\sigma$. An analog is drawn between the behaviour of a closed line di location in a stress field and the behaviour of a close current-carrying loop in a field of magnetic inductio Then formulae for the stress components caused any point of an infinite elastically isotropic crystal by line element of a general Burger's dislocation a deduced from Burger's expressions for the displac ments. These formulae bear a close analogy to th Biot–Savart formula of electromagnetic theor Both of these results taken together constitute a con plete system for the investigation of the mutual inte action of dislocations in an infinite elastically isotrop crystal.

539.3

2095. Hardening and relaxation as basic phenomer of plastic deformation. M. A. BOLSHANINA. *Iz Akad. Nauk, SSSR, Ser. Fiz*, **14** (*No.* 2) 223–31 (195 *In Russian.*

An hypothesis is advanced that the process plastic deformation is composed of two concurre processes, those of hardening and relaxation. On th basis a polytropic equation is derived which describ qualitatively all the characteristics of the flow curve Maxwell's relaxation equation is corrected. number of experimental results from tensile tests c various metals is adduced to support this hypothesi and it is further applied to explain some other chara teristics of plastic deformation, e.g. the effect of d formation velocity on the path of the flow curve ar the stronger effect of this velocity on the flow curv of low melting-point metals. The hypothesis is als used to establish relations between the dynamic coe σ_1/σ_2 [where σ_1 and σ_2 are the stresses correspondir to deformation velocities v_1, v_2 $(v_2 > v_1)$], meltir point and experimental temp., and also to establis relations between energy absorbed, deformatic velocity and melting point. W. HUGH

539.3

2096. Energy absorption in deformations of opposi sign in copper. M. M. DEGTYAREV. *J. Tech. Phys. USSR*, **20**, 440–6 (*April*, 1950) *In Russian.*

It is shown experimentally that the main part of th absorbed energy in plastic deformation is the fractic of the energy of the residual stresses. Furthermor it is found that in compression deformation of C specimens preliminarily put under tensile stress, the is at first a relief of the residual stresses from th tensile pre-stressing, and only after reaching high degrees of deformation does an accumulation of late energy in the specimen take place. The speci machine designed for the tests and the measuring se up are described. B. F. KRA

539.374

2097. Theory of the influence of the speed on the resistance of metals to plastic deformation. L. D. Sokolov. *J. Tech. Phys., USSR*, **20** (*No.* 4) 447–57 (*April*, 1950) *In Russian.*

Discussion of the numerical evaluation of analytical expressions of the relation between resistance to plastic deformation and rate (speed) of deformation from some modern theories of plasticity. Most suitable and corresponding to experimental facts are relations $\sigma = \sigma(v)$ obtained by comparing athermal and thermal plasticity, the latter being well represented by the temperature relation of the relaxation time $\tau = \tau_0 \exp(U(\delta)/kT)$, where $U(\delta)$ is the activation energy depending on the degree of deformation. Dislocation theories based on considerations of microplasticity give correct relations for small deformations. The validity of the Zener–Hollomon formula is confined to regions of low homologous temperatures [Abstr. 1174 (1944)]. From examination of Vitmans and Stepanov's [*J. Tech. Phys., USSR*, **9**, 1070 (1939)] as well as the author's own formulae, it appeared that these are suitable and convenient for practical calculations provided the coefficient n of the Vitman–Stepanov formula is known as a function of the homologous temperatures, the degree of deformation and number of admixtures to the base metal.

B. F. KRAUS

539.374

2098. The correspondence principle in the theory of plastic deformation. M. F. Lashko. *J. Tech. Phys., USSR*, **20**, 880–3 (*July*, 1950) *In Russian.*

The theory of plastic deformation of solids is based on investigations of anisotropic monocrystals and isotropic (or rather quasi-isotropic) bodies. For each of these two domains of investigation relationships of plastic deformation have been established. For monocrystals these were formulated in terms of the elementary deformation phenomena taking the form of crystallographic displacements and twinning. For the quasi-isotropic body the relationships concern distribution of stresses and deformations, not considering the character of the plastic deformations in individual monocrystalline grains. The macroscopic phenomena are investigated by optical methods, etching figures, etc. Yet the plastic deformation in the grain-size monocrystals of the quasi-isotropic body proceeds by the same elementary processes of displacement and twinning as in isolated monocrystals. The different principles of investigation introduce here the same kind of artificial duality as in many other fields of science, physics above all. In analogy to principles of correspondence in other fields, this seems particularly necessary and appropriate in plastic deformation. It may be formulated thus: The plastic deformation in the individual grains of the quasi-isotropic body proceeds similarly as in an isotropic crystal line body and is produced by the elementary processes of displacement and twinning characteristic of the monocrystal.

B. F. KRAUS

539.374

2099. Failure of metals as a consequence of dislocations. N. F. Lashko. *J. Tech. Phys., USSR*, **20**, 884–7 (*July*, 1950) *In Russian.*

The unsatisfactory subdivision of metal failures into viscous and brittle failures (represented as failure without preceding plastic deformation) should be replaced by a more adequate theory, especially as there is no agreement yet on the kinetics of the development of the viscous failure in solid bodies and, more particularly, on the role of the dislocations in it. The final phase of the viscous failure of a solid body is preceded by plastic deformations which partly constitute weakening and partly solidification processes. The latter feature is thought to be partly due to displacements or dislocations prohibiting slipping in certain directions. It is ultimately a question of local damage and the character of the dislocations on points of weakness of the material which decides where the general failure originates. These points become centres of dislocation or displacement faces, and on these the disruption of the continuity of the solid starts. This theory is demonstrated by microphotographs.

B. F. KRAUS

539.374 : 539.26

2100. Structure of a deformed metallic grain. J. A. Ramsey. Letter in *Nature, Lond.*, **166**, 867–8 (*Nov.* 18, 1950).

X-ray and micrographic studies on polycrystalline Zn shows that, upon deformation, the grains break down into a number of fragments, the degree of perfection, and probably the size, of which increase with increasing temperature of deformation.

A. E. De Barr

539.374 : 539.4.016.2

2101. Influence of the character of preliminary work-hardening on the softening of a metal in plastic deformation. L. I. Vasilev. *J. Tech. Phys., USSR*, **20**, 458–60 (*April*, 1950) *In Russian.*

It is found that in the tensile stressing of tin specimens after a preliminary substantial deformation by extrusion through a nozzle and drawing, a reduction of the deforming pressure is observed, which contradicts the normal experience. A possible explanation is that in certain conditions the relief of the preliminary work-hardening stresses will not compensate for the deformations of the tensile stressing, i.e. the relaxation will overlap with the hardening or solidifications.

B. F. KRAUS

539.375 : 548.0

2102. Reasons for the characteristics of breakdown of elasto-anisotropic bodies. A. V. Stepanov. *Izv. Akad. Nauk, SSSR, Ser. Fiz.*, **14** (*No.* 1) 122–41 (1950) *In Russian.*

Theoretical. Methods of representing the elastic properties of elasto-anisotropic bodies and evaluating the acting stresses in anisotropic bodies are discussed. In comparing elasto-anisotropic and elasto-isotropic bodies the following points are considered: the state of stress depends on the angle between the directions of the acting force and the axes of anisotropy of the sample; the direction of max. stress does not coincide with the direction of max. deformation; the direction of max. stress does not coincide with the direction of the acting force; the state of stress depends on the period of the acting force (e.g. the difference between figures of pressure and strike for crystals); in anisotropic laminae the effect of the concn. of stress along the direction of the highest value for Young's modulus, and deconcentration for the direction with the least

value for Young's modulus is manifest; there exist characteristic forms of stress inherent in all anisotropic media, and consequently analogous forms of breakdown; the results of interaction of an external force depend on its sign. W. HUGHES

539.375

2103. On the dislocation, the group of holonomy and the theory of yielding. K. KONDO. *J. Soc. Appl. Mech. Japan*, **3** (*No.* 7) 107–10 (1950).

A discussion in general terms of the author's treatment of elastic dislocation by the methods of Riemannian geometry. [See Abstr. 2930, 3436 (1950)]. R. A. NEWING

539.383 : 548.0

2104. Compressibility and absorption frequency of ionic crystals. B. SZIGETI. *Proc. Roy. Soc. A*, **204**, 51–62 (*Nov.* 22, 1950).

A simple relation is derived between the two quantities. It takes into account the change which a displacement induces in the electronic configuration, and is independent of the uncertainty concerning the Lorentz force. Comparison with experimental data shows very good agreement in the case of the alkali halides. The changes in the electronic configuration of each ion are described in terms of a dipole moment and in terms of "local distortions." The latter are caused by forces not included in the Lorentz force, and it is assumed that they are localized in small regions in the immediate neighbourhood of the neighbouring ions. The local distortions are responsible for the deviation of the polarization from the value given by the Lorentz force; from the sign of this deviation it is concluded that they are due mainly to the non-electrostatic repulsive forces. Although this model allows deviations from spherical charge distribution around the ions, it nevertheless permits the splitting of the energy of certain types of displacements into two-body interactions and leads to the Cauchy relations between the elastic constants. A.

539.4

2105. Tensile properties of ingot iron at low temperatures. G. W. GEIL AND N. L. CARWILE. *J. Res. Nat. Bur. Stand., Wash.*, **45**, 129–47 (*Aug.*, 1950).

True stress-strain curves obtained in tension tests at temperatures ranging from −196° to +100°C with ingot iron as annealed, normalized, quenched and tempered, hot-rolled and cold-drawn are presented. Numerous simultaneous load and diameter measurements were made during the entire course of each test. The effects of prior thermal and mechanical treatment of the iron on the true stress-strain relations are discussed. Graphs are presented showing the influence of the testing temperature, the ferrite grain size and the initial condition of the iron on the work-hardening characteristics, namely, strain-hardening and strain-ageing. The effects of the above factors on yield stress and ultimate stress, and on true stress and true strain at maximum load and at fracture, are presented. The twinning of iron in the tests at low temperatures is briefly discussed. A.

539.4

2106. On the Fredrickson–Eyring theory of the mechanical behaviour of metals. J. FLEEMAN AND G. J. DIENES. Letter in *J. Appl. Phys.*, **21**, 1193–4 (*Nov.*, 1950).

Unloading and reloading curves for steel at various temperatures and strain-rates are calculated on the basis of the statistical rate theory of metals proposed by Fredrickson and Eyring [*Metals Tech.*, *TP*2423 (*Aug.*, 1948)]. Approximate calculations are also made of the rate of strain-recovery. The results indicate that the theory predicts too much strain hardening; it also fails to account for the permanent deformation in steel at temperatures −70° to 100°C. A. T. PRICE

539.4 : 548.7

2107. The stresses and energies asosciated with inter-crystalline boundaries. J. K. MACKENZIE. Letter in *Proc. Phys. Soc., Lond. A*, **63**, 1370 (*Dec.*, 1950).

See Abstr. 6103 (1950). The interaction energy between two square lattice planes (the case considered there) has been calculated and the results are given here.

539.42 : 548.24

2108. Influence of twinning on the brittle failure of zinc crystals. E. S. YAKOVLEVA AND M. V. YAKUTOVICH. *J. Tech. Phys., USSR*, **20**, 420–3 (*April*, 1950) *In Russian.*

The process of twinning under compression of Zn crystals orientated with their hexagonal axis along the direction of compression facilitates rupture in those cases where the deformation occurs in conditions preventing a deformation by slip. It may be assumed that the same effect of the twinning may be observed in the tensile stressing of Zn crystals with their hexagonal axis perpendicular to the direction of the tensile stress applied, when slip deformation is excluded, as a similar argument must hold in this case. B. F. KRAUS

539.434

2109. On the stationary creep rate. N. S. FASTOV. *J. Tech. Phys., USSR*, **20**, 543–5 (*May*, 1950) *In Russian.*

It is shown that the only empirical quantitative relation so far established on the creep rate in the steady phase of this 3-phase process, viz. $v = v_0 \sinh \sigma/\sigma_0$, where σ is the stress applied, and v_0 and σ_0 are constants of the material, must be supplemented by a temperature relation for the stationary creep rate, the suggested form of which is $\log v = a_0 - a_1/T + b_0(1 - T_{crit}/T)\sigma$, where all constants, including T_{crit}, can be determined experimentally. This relation represents correctly the "reversal" of the sense of the variation of the creep rate v. stress at the "critical" temperature. B. F. KRAUS

539.434

2110. Creep of high-purity copper. W. D. JENKINS AND T. G. DIGGES. *J. Res. Nat. Bur. Stand., Wash.*, **45**, 153–73 (*Aug.*, 1950).

Creep tests were made at 110°, 250° and 300°F on annealed oxygen-free high-conductivity Cu. The rate of loading to the ultimate had a significant effect on the amount of plastic extension and thereby affected the creep behaviour. The strain rate during the so-called 2nd stage of approximately constant

rate was not constant but varied in a cyclic manner. A less-pronounced cyclic variation was also evident in both the 1st and 3rd stages. The beginning of the 3rd stage was often accompanied by microcracking, but in other tests this stage was initiated without the presence of such cracks. The parent grains were fragmented during creep, and strain markings were observed in all specimens carried to complete fracture. A.

539.53 : 548.0

2111. Variation of the microhardness of single crystals as a function of the orientation of a pyramidal indenter. H. ROTH-MEYER. *C.R. Acad. Sci., Paris*, **231**, 906–8 (*Oct.* 30, 1950) *In French.*

An examination of the form of the indentations in Al when the indenter diagonals are perpendicular to the slip lines and at 45° to this position. Photographs illustrate the phenomena for the (110) and (100) faces. Similar observations have been made on Pb and Cu. The form in the case of a hexagonal metal (Zn) is also discussed. The variation of the lengths of the indenter diagonals with orientation (relative to a crystal direction) in the crystal face is sinusoidal, but the period varies for the different cases. The advantages of the pyramidal shape are noted. A. J. KENNEDY

539.536 : 539.374 : 537.311.31

2112. The Rehbinder effect. E. N. DA C. ANDRADE, R. F. Y. RANDALL AND M. J. MAKIN. *Proc. Phys. Soc., Lond. B*, **63**, 990–5 (*Dec.*, 1950).

According to Rehbinder the immersion of wires of certain metals in non-polar paraffin containing a little oleic acid increases the rate of flow of the metal under a given stress and increases the electrical resistivity. The experiments described show that the mechanical effect can be obtained with single crystals of Cd if the surface is contaminated by a thin oxide layer, which is known to increase the critical shear stress, but not if the surface is clean. The effect is accordingly attributed to the disruption of the hardening surface layer by the active agent and not to penetration into the metal, as assumed by Rehbinder. It has not been found possible to detect any electrical effects with Cd or Pb crystal wires having either clean or contaminated surfaces. A.

539.62

2113. Friction coefficient in sliding and scratching of metals. E. N. MASLOV. *J. Tech. Phys., USSR*, **20**, 888–91 (*July*, 1950) *In Russian.*

A special testing machine was designed for measuring the friction forces in sliding and scratching contact. The friction coefficient in scratching contact, and also in cutting friction under various tools, is considerably higher than in sliding friction, which is non-destructive. This is explained not only by cleaner and larger contact areas in scratching friction, but even more due to the removal of very thin metal layers near the cut and to the raising of the edges of the latter. B. F. KRAUS

539.622

2114. Föppl's theory of rolling friction. G. HEINRICH. *Öst. Ingen. Arch.*, **4** (*No.* 5) 363–75 (1950).

The author proves that the contact condition of Hertz is not met by the Föppl equations. In case of equal elastic constants of the contacting parts only the Hertz pressure distribution is possible. The formulae for the distribution of clinging stress and of perpendicular pressure are really more simplified than with Föppl. The slip is calculated and compared with the results of trials made by G. Sachs. Rolling friction power is also calculated. A.

PHYSICAL CHEMISTRY 541

PHASE EQUILIBRIUM . CHEMICAL REACTIONS 541.11/.12

541.123.2

2115. An experimental and thermodynamic investigation of the hydrogen-titanium system. A. D. MCQUILLAN. *Proc. Roy. Soc. A*, **204**, 309–23 (*Dec.* 22, 1950).

The temperature-pressure-concentration relationships of the H–Ti system have been studied, and its more important thermodynamic aspects considered. Part of the equilibrium diagram has been established, and free-energy curves for the α- and β-solutions have been plotted for a number of temperatures. The experimental results have been used to obtain values for the latent heat of the $\alpha \rightleftharpoons \beta$ transformation and the transformation temperature. A.

541.124 : 541.64

2116. Statistical kinetics of Hevea rubber cyclization. M. GORDON. *Proc. Roy. Soc. A*, **204**, 569–85 (*Jan.* 9, 1951).

Dilatometric experiments on rubber emulsions in sulphuric acid have shown that the cyclization reaction conforms in the main with a statistical cyclization law much better than with a 1st-order equation uncorrected for the survival of stranded units. High accuracy was required for this experimental distinction, whose importance lies in the implicit proof that the polymer units participate in the rate-determining transition complex, in accordance with the accepted proton transfer mechanism. A kinetic proof has incidentally been furnished for the fact that the rubber polymer contains long chains of identical units. When handled by an emulsion technique, this polymer can provide a useful "model compound" for its simpler terpene analogues. Certain rate abnormalities have been observed, including an induction period of reduced rate, probably connected with diffusion effects. A small volume change subsequent to the cyclization reaction may reflect a prototropic double-bond shift. The activation energy and entropy are found to be lower than in previous work, an effect traced in part to a curvature of the Arrhenius plot. The known dependence of cyclization rate on Hammett's acidity function H_0 is quantitatively confirmed. A.

541.126

2117. A study of sensitized explosions. X. The kinetics of decomposition of chloropicrin and of the hydrogen-oxygen and hydrogen-chlorine reactions sensitized by chloropicrin. P. G. Ashmore and R. G. W. Norrish. *Proc. Roy. Soc. A*, **204**, 34–50 (*Nov.* 22, 1950).—See Abstr. 691 (1951) for Part IX.

541.126

2118. Kinetics of the hydrogen/oxygen reaction. I. The explosion region in boric acid-coated vessels. A. Egerton and D. R. Warren. *Proc. Roy. Soc. A*, **204**, 465–76 (*Jan.* 9, 1951).

The region of low-pressure explosion for H/O mixtures in boric-acid-coated vessels has been observed over a wide range of temperature, vessel size and mixture ratio. The results obtained cannot be explained by any of the existing mechanisms, and appear to conflict with the present interpretation of the effects of boric-acid coating. The explosion boundary is described by a simple mathematical expression which demands the participation of a 2nd-order chain-branching process not operative in salt-coated vessels. The previously excluded reaction $H + HO_2 \rightarrow OH + OH$ is postulated. A mechanism is outlined which successfully accounts for the shape and temperature dependence of the newly observed explosion region. A.

541.127

2119. Kinetics of the reduction of ferrous oxide by hydrogen. J. Benard and J. Moreau. *C.R. Acad. Sci., Paris*, **231**, 904–6 (*Oct.* 30, 1950) *In French.*

The reduction of thin layers of FeO at constant temp. (between 450 and 700°) has been investigated. At 500° there is a latent period during which there is no loss of weight (20 min). This is followed by a period of regular acceleration of the reduction (10 min), and this by a period of uniform reduction (23 min). Then there is a period of retardation finishing with the complete reduction of the oxide. The latent period corresponds to the formation of nuclei of Fe which promote the further reduction. At temp. less than 500° the latent period is very much longer, and at 450° reduction had not set in after 2½ hours' contact with H_2. At temp. above 500° there is a rapid disappearance of the latent period, and it is absent altogether at 550°. There is a longer period of retardation due to the transformation of very permeable, incompletely reduced Fe crystals into less permeable Fe crystals. At 700° this takes place very near the origin of the mass-time curve which exhibits no real linear portion. X-ray investigations show that at this temp. reduced Fe undergoes a very rapid reorganization immediately it is formed. A. J. Mee

541.127

2120. Kinetic studies on carbohydrates in alkaline conditions. I. The kinetics of the autoxidation of glucose. C. H. Bamford and J. R. Collins. *Proc. Roy. Soc. A*, **204**, 62–84 (*Nov.* 22, 1950).

541.127

2121. Kinetic studies on carbohydrates in alkaline conditions. II. The kinetics of the rearrangements of glucose and fructose in alkaline solution. C. H. Bamford, D. Bamford and J. R. Collins. *Proc. Roy. Soc. A*, **204**, 85–98 (*Nov.* 22, 1950).

541.128.13 : 541.183.2

2122. The variation of rate of desorption with extent of surface coverage. J. Weber and K. J. Laidler. Letter in *J. Chem. Phys.*, **18**, 1418 (*Oct.*, 1950).

541.128.13 : 541.183.2

2123. Catalysis: retrospect and prospect. H. S. Taylor. *Disc. Faraday Soc., No.* 8, 9–18 (1950).

The facts of chemisorption are briefly reviewed, and an endeavour is made to reconcile the "active centre" and the "crystal parameter" hypotheses. The importance of traces of certain impurities in modifying the efficiency of the catalyst is stressed, and is related to Mott's idea of impurity centres. The presence of ions of variable valency is particularly important, and light is thrown on the role they play, by a study of semi-conductors. Impurity centres reduce the heat of chemisorption and with it the efficiency of the catalyst; at the same time a catalyst with impurity centres will be more resistant to poisoning. The importance of the *d*-band character of the catalyst in hydrogenation reactions is also stressed. Finally, the recent views of Volkenstein [*Zh. Fiz. Khim.*, **23**, 917 (1949)] are explained at some length: chemisorption and catalysis are to be considered in terms of microdefects of the catalyst; these are regions of the lattice where there are vacant sites, interstitial atoms or ions, ions in a heteropolar lattice with normal positions but anomalous charge, or foreign atoms in substitutional or interstitional positions. The microdefects may react, attract or repel one another, or interact to produce a new defect with different properties. A defect may be "biographical," i.e. it depends on the mode of preparation and is present at 0°K; or "thermal," i.e. the disorder increases with rise in temperature. Chemisorption occurs in the region of the defect. Many observations from the older literature can be interpreted in terms of the Volkenstein concepts.

S. J. Gregg

541.128.13 : 541.183.2

2124. Adsorption and catalysis on oxides. Introductory paper. W. E. Garner. *Disc. Faraday Soc., No.* 8, 211–15 (1950).

Oxide catalysts may be divided into (*a*) semiconductors, (*b*) insulators. In (*a*) there is a higher mobility within the lattice than in (*b*) so that lattice defects are more readily produced. Around these defects (due to excess of oxygen or metal respectively) there is a variety of surface energy levels and this is important for catalysis. Chemisorption in some cases occurs on the whole catalyst, in others on parts only, e.g. at defects or at Frenkel steps. The chemisorption of (i) H_2, of (ii) CO and of (iii) hydrocarbons is considered; there are two views as to (iii), either that free radicals or that carbonium ions are formed. There are several types of promotion and of poisoning, and some are considered. Insulators are used for dehydration, for isomerization, polymerization and cracking of organic molecules, and the reasons for this are discussed. S. J. Gregg

541.128.13 : 541.183.56

2125. Adsorption and catalysis on metals. Introductory paper I. E. K. RIDEAL. *Disc. Faraday Soc., No.* 8, 96–9 (1950).

Adsorption of a gas (*G*) on a metallic surface (*S*) may take place either by means of van der Waals' forces, giving physical adsorption, or by an electron switch, giving a heteropolar or covalent bond between *S* and *G*. In catalysis, reaction may proceed by interaction between (i) two different chemisorbed species, or (ii) a chemisorbed species and a physically adsorbed molecule, or (iii) a molecule arising from the gas phase and a chemisorbed molecule. The fall in heat of adsorption as the degree of covering increases is not invariably due to heterogeneity of the surface and can be caused by repulsive forces between the adsorbed atoms or radicals. The catalytic hydrogenation of ethylene is discussed in the terms outlined above. S. J. GREGG

541.128.13 : 541.183.56

2126. Adsorption and catalysis on metals. Introductory paper II. D. D. ELEY. *Disc. Faraday Soc., No.* 8, 96–9 (1950).

Subdivides the subject under the following headings: Chemisorption of gases on metals: Chemisorption of H_2 and of O_2 but not of N_2 is very fast (even at −183°c). Physical adsorption and (with H_2) penetration of the lattice may complicate the results. The para-hydrogen conversion. The hydrogenation of ethylene: The various mechanisms that have been proposed are briefly described, and the relevance of work on the exchange of D atoms between D_2 and C_2H_4 molecules is indicated. The lattice-spacing factor. Electronic factors: The presence of holes in the *d*-band of the metal is important for the formation of a strongly bound activated complex. S. J. GREGG

ELECTROCHEMISTRY 541.13

541.13

2127. Role of ion hydration in the electrolytic polishing bath. E. DARMOIS, I. EPELBOIN AND D. AMINE. *C.R. Acad. Sci., Paris,* **231,** 1222–3 (*Nov.* 27, 1950) *In French.*

The optimum composition of the electrolytic polishing bath is shown to be related to the degree of ion hydration. The role of additions to the bath and the relation of optimum composition with temperature and quantity of metal dissolved can now receive a possible explanation. H. H. HODGSON

541.133

2128. Relationship between conductivity of the system ethanol + water + sulfuric acid and the solvent composition. I. SANGHI, D. S. DATAR AND S. H. ZAHEER. Letter in *J. Chem. Phys.*, **18,** 1415–16 (*Oct.*, 1950).

541.134

2129. Method of measuring the absolute potential of aqueous half-cells. W. A. PATRICK AND C. L. LITTLER. *J. Phys. Coll. Chem.*, **54,** 1016–27 (*Oct.*, 1950).

A cathode-ray oscillograph, with triple amplification of the input signal, is found to be satisfactory for the detection of transient currents between a stationary electrode immersed in an aqueous solution containing a reactive ion and a similar electrode freshly dipped into the same solution. Deflections have been observed for the following systems: Zn, Zn^{++}; Cd, Cd^{++}; Tl, Tl^{++}; Co, Co^{++}; Ni, Ni^{++}; Sn, Sn^{++}; Pb, Pb^{++}; Cu, Cu^{++}; Hg, Hg_2O, NH_4OH; Ag, $AgIO_3$ (*s*), KIO_3; Au or Pt, Fe^{++}, Fe^{+++}, SO_4^{--}, H^+; Au or Pt, quinhydrone; Au, $K_4Fe(CN)_6$, $K_3Fe(CN)_6$, KNO_3, and reversal points observed from the last 5 of them. The potentials of electrodes in solutions of proper concentration for reversal were then measured against a calomel half-cell, and the overall potential was taken to be the single potential of the calomel electrode. There are 3 diagrams and 13 references. H. H. HODGSON

541.135.2

2130. The problem of the H^+ ion in electrolytic solutions. E. DARMOIS. *J. Phys. Radium,* **11,** 577–82 (*Nov.*, 1950) *In French.*

The difficulties caused by the assumption of $(H_3O)^+$ as the state of the hydrogen ion in aqueous solution are discussed, and the theory is advanced that the ion is probably a proton which exists within a cage formed by a certain number of water molecules. An explanation is then given to account for its high conductivity and large heat of hydration, and also for failure to obtain the Raman spectrum of $(H_3O)^+$. Further, the ability of hydrogen to penetrate certain metals is shown to be directly related with the above conception of the hydrogen ion. 21 references.

H. H. HODGSON

PHOTOCHEMISTRY . RADIATION CHEMISTRY 541.14

541.14

2131. Instantaneous electron transfer and interaction absorption. F. P. DWYER, E. C. GYARFAS AND D. P. MELLOR. Letter in *Nature, Lond.*, **166,** 746 (*Oct.* 28, 1950).

Since it is possible to detect rapid electron transfer without any chemical or physical separation of oxidized and reduced forms, mixed solutions of $[Os^{II}(dipy)_3](ClO_4)_2$ and $[Os^{III}(dipy)_3](ClO_4)_3$, have been examined for interaction absorption in the region 7 000–4 000 Å, since such systems are suitable for the purpose; none was detected. Bonner [*J. Amer. Chem. Soc.*, **71,** 3909 (1949)], however, has shown that electron transfer may be quite a slow process, and the above failure does not rule out correlation between the two phenomena. H. H. HODGSON

541.14

2132. Alteration of collagen structure by irradiation with electrons. R. R. PERRON AND B. A. WRIGHT. Letter in *Nature, Lond.*, **166,** 863–4 (*Nov.* 18, 1950).

541.14

2133. Oxidation by photochemical electron transfer excitation. H. G. C. BATES, M. G. EVANS AND N. URI. Letter in *Nature, Lond.*, **166,** 869 (*Nov.* 18, 1950).

541.14 : 537.531.9 : 539.164.93

2134. Radiochemical equilibria in irradiated water. P. Bonet-Maury and M. Lefort. *Nature, Lond.*, **166**, 981–2 (*Dec.* 9, 1950).

The production of H_2O_2 by the action of X-rays and of alpha-radiation on water [with and without the addition of a complexing agent (titanium sulphate)], was investigated, and the results are held to support the authors' view that the processes are controlled by two separate mechanisms. [The legends of the 2 ordinate scales in Fig. 3 appear to have been transposed.] A. O. STANESBY

541.14 : 539.164

2135. Polymerization of *iso*butene by α-particles. W. Mund and P. Huyskens. *Bull. Acad. Roy. Belg. Cl. Sci.*, **36** (*No.* 8–9) 610–15 (1950) *In French.*

Under irradiation with α-particles *iso*butene polymerizes according to a law similar to that observed for vinyl chloride. The temperature coefficient of the reaction is negative, possibly on account of the effect of temperature on the length of the polymerization chains. C. B. ALLSOPP

DISPERSIONS . COLLOIDS . ADSORPTION
541.18

541.18 : 530.162

2136. On the interaction of colloidal particles. IV. General mathematical theory for two identical particles. S. Levine. *Proc. Camb. Phil. Soc.*, **47** (*Pt* 1) 217–29 (1951).

See Abstr. 3475 (1950) for Part III. A general theory of the interaction of two charged identical colloidal particles of arbitrary shape is developed. An expression for the Helmholtz free energy of the electric double layers is obtained by the methods of statistical mechanics. The condition that there is equilibrium between the ions adsorbed on the surfaces of the colloidal particles and those dissolved in the dispersion medium is accounted for by requiring that the free energy of the whole system be a minimum with respect to variation of the ionic density on the surfaces. The theory is a further development of the work of Verwey and Overbeek. The conclusions are that in dilute sols, to which the investigations are restricted, the results of these authors require extension in two directions. First, there is a correction to the mutual energy of two particles, due to the Coulomb interaction of the ions in the bulk of the solution. Secondly, no special assumption concerning the relation between the surface potential (or charge) and interparticle separation need be introduced. The equations set up to determine the free energy of interaction at the same time yield the "adsorption isotherm" for the ion type which is common to the solution and the surface of the particle. A.

541.18 : 530.162

2137. On the interaction of colloidal particles. V. Nature of repulsion between particles in dilute sols. S. Levine. *Proc. Camb. Phil. Soc.*, **47** (*Pt* 1) 230–42 (1951).

The Coulomb interaction of the ions in the dispersion medium is shown to contribute an additional repulsion term to the mutual free energy of the two particles, which behaves as an inverse power and is the predominant effect at large separations, although it is a second-order effect at small separations. For parallel plates, this power is the fourth, and for two spheres, the sixth. A tentative calculation shows that, at least for thin plates and low electrolyte concentrations, the new repulsion will outweigh the attractive London–van der Waals' force considered by Verwey and Overbeek, and more recently by Casimir and Polder [Abstr. 1286 (1948)], when the plates are far apart. A.

541.18.04 : 532.613

2138. The rate of surface tension lowering and its role in foaming. E. J. Burcik. *J. Coll. Sci.*, **5**, 421–36 (*Oct.*, 1950).

Measurements on solutions of sodium laurate, dodecyl sulphate and oleate are correlated with foam-stability. R. F. BARROW

541.182.2

2139. The methods of forming, detecting and measuring the size and concentration of liquid aerosols in the size range of 0·01 to 0·25 microns diameter. V. K. La Mer, E. C. Y. Inn and I. B. Wilson. *J. Coll. Sci.*, **5**, 471–96 (*Oct.*, 1950).

It is found that aerosol droplets of a size too small to be measured by the usual optical methods can be "grown" in a controlled and quantitative manner until they can be so measured. The most sensitive optical method depends on the measurement of the polarization of scattered light. An aerosol of very small droplets ($< 0{\cdot}08\,\mu$) is exposed to a suitable solvent (e.g. H_2SO_4 to H_2O and dibutyl phthalate to toluene or xylene) and the droplets allowed to increase in size by condensation of the solvent vapour. A tenfold increase in radius can be achieved in this way and growth by a factor of five can be controlled quantitatively. This produces a "dilution" of the substance forming the aerosol and by suitable filtration this can be determined. Accurate measurements can be made down to particle diameters of $0{\cdot}02\,\mu$ and estimates of size down to $0{\cdot}006\,\mu$. Details are given of the aerosol production. J. IBALL

541.182.5 : 539.16

2140. Emanating power and the age of complex silica gels. F. Běhounek and C. Jech. Letter in *Nature, Lond.*, **166**, 792–4 (*Nov.* 4, 1950).

Silica gels, containing adsorbed radium and prepared some 15 years ago, have been examined recently and their emanating power remeasured. Because of the large colloidal surface of these gels radon is given off almost quantitatively, but any crystallization will modify this and thus the process of "ageing" of the gels can be followed. The gels contain electrolytes of iron and of metals such as Mn and Mg, and the results indicate that these complex gels sometimes behave as pure silica gels in which little or no ageing can be observed over 15 years, or as montmorillonites which show appreciable crystallization and consequently a lower emanating power (emanating power is defined as the ratio of radon escaping from the sample to the radon developed in it). Drops of very dilute suspensions of the gels were placed on "nuclear" photographic plates. "Stars" produced by α-rays are observed and give

qualitative information regarding emanating power, and from measurement of the number of α-rays comprising a star an estimate of the radioactive content of the gel particles can be made. J. IBALL

541.182.6 : 539.27

2141. Electron microscopic studies on aqueous sols. M. R. A. RAO. *Proc. Phys. Soc., Lond. B*, **63**, 980–1 (*Dec.*, 1950).

Electron micrographs are shown for aqueous sols containing the following colloidal suspensions: graphite, stearic acid, V_2O_5 and S. The results obtained explain certain divergences noticed during the measurement of depolarization of light scattering in these colloidal solutions. A.

541.183

2142. The expansion of charcoal upon the adsorption of gases and vapors. R. I. RAZOUK AND M. A. ELGOBEILY. *J. Phys. Coll. Chem.*, **54**, 1087–97 (*Nov.*, 1950).

The expansion which charcoal undergoes when it adsorbs the vapour of CH_3OH, NH_3, CO_2, O_2 and SO_2 has been measured at certain temperatures by means of a silica extensometer. In agreement with the findings of Bangham and co-workers, the expansion of charcoal was found to be proportional to the lowering of its surface free energy accompanying the adsorption. The proportionality constant was independent of temperature and of the adsorbate. Expansion-adsorption measurements indicate that the adsorbed films were mobile, and that they obeyed equations of state similar to those of compressed gaseous and liquid-expanded films on the surface of water. The specific surface of the charcoal used was estimated as 575 m^2 $gram^{-1}$, and the amount adsorbed corresponded to less than a monomolecular layer even in the neighbourhood of saturation. A.

541.183

2143. Note on the physical adsorption of gases in capillaries and on small particles (nucleation of condensation). T. L. HILL. *J. Phys. Coll. Chem.*, **54**, 1186–91 (*Nov.*, 1950).

An approximate theoretical picture, which leads to good agreement with experiment in some cases of physical adsorption on non-porous solids, is extended to adsorption in pores and on small spherical particles. The phenomena of capillary condensation and nucleation of condensation of a supersaturated gas are discussed in this connection. A.

541.183 : 536.71 : 530.162

2144. Statistical thermodynamics of multimolecular adsorption. I. S. ONO. *J. Phys. Soc. Japan*, **5**, 232–7 (*July–Aug.*, 1950).

The hole theory of liquids developed, and extended to the case of surface layers between the liquid and vapour phase by the author [Abstr. 5971 (1949) and 5572 (1950)] is now extended to adsorption of gases on a solid wall. T. C. TOYE

541.183 : 539.133 : 539.155.2

2145. Occurrence of tunnel effect during adsorption and desorption of isotopes of hydrogen. P. HARTECK AND G. A. MELKONIAN. *Naturwissenschaften*, **37** (*No.* 19) 450 (*Oct.*, 1950) *In German.*

An attempt to explain high separation factors, found in the adsorption-desorption experiments with H at low temperatures and low gas/adsorbent ratio, by assuming the presence of tunnel effect (for the first time in molecular chemistry). F. LACHMAN

CHEMICAL STRUCTURE 541.4/.6

541.553

2146. Directed valence in IF_5 and IF_7. R. L. SCOTT. Letter in *J. Chem. Phys.*, **18**, 1420–1 (*Oct.*, 1950).

541.57

2147. Overlap integrals and chemical binding. R. S. MULLIKEN. *J. Amer. Chem. Soc.*, **72**, 4493–503 (*Oct.*, 1950).

Values of Slater atomic-orbital overlap integrals are calculated for single and multiple bonds of first- and second-row atoms with one another and with H. The use of overlap integrals as indications of bond strength is discussed. The relatively large overlaps for *s* bonds (in disagreement with Pauling) and of π bonds at moderate and small bond lengths are pointed out. Hybrid *s–pσ* bonds also have large overlaps. There is a striking increase in reduced bond length (i.e. actual bond length/the sum of the theoretical atomic radii) on going to the right of the periodic table for homopolar bonds in the first and second rows. This is explained in terms of the orbital overlaps. The differences between first- and second-row atoms with regard to formation of multiple bonds, and to strengths of single bonds in the last columns of each row can be ascribed to the increased strengths of σ bonds in the second row. Metallic binding is discussed briefly. Using a new polarity index, the relative shortening of bond lengths in polar bonds is found to be related to this index, except in the case of hydrides. There is the possibility of appreciable resonance structure contributions involving π bonding in hydrides. Overlap integrals may be useful in calculating van der Waals' and non-bonded repulsion energies. Exchange repulsions between inner shells of bonded atoms are negligible. A. J. MEE

541.63

2148. Rotational isomerism in perfluoro paraffins. G. J. SZASZ. Letter in *J. Chem. Phys.*, **18**, 1417–18 (*Oct.*, 1950).

541.64 : 532.712 : 535.434

Comparison of molecular weights of polystyrene by the light-scattering and osmometric methods. *See Abstr.* 1776

541.64 : 535.434

Photoelectric light-scattering photometer for determining high molecular weights. *See Abstr.* 1777

LABORATORY APPARATUS 542.1/.7

542.1 : 539.16

2149. Practical aspects of surface decontamination. P. C. TOMPKINS, O. M. BIZZEL AND C. D. WATSON. *Nucleonics*, **7**, 42–54 (*Aug.*, 1950).

Decontamination tests made with $H_3P^{32}O_4$,

$Ba^{140}Cl_2$ and NaI^{131} on a number of common laboratory materials such as concrete, plywood, stainless steel and Pyrex as well as a number of possible coating substances: varnishes, plastic, sheets, enamels. The latter compare quite favourably with stainless steel and Pyrex both as regards susceptibility to contamination and spill index (the common logarithm of the fraction of a contaminating sample, which remains attached to the surface, after a two-step decontamination, carried out within one hour of the spill). Experiments on the mechanism of the exchange of radioactive material between the surface and reagent, carried out with $H_3P^{32}O_4$ on Pyrex glass show that both contamination and decontamination proceed rapidly at first and then very slowly, and that it is this slow exchange rate which limits the degree of decontamination which can be achieved. Procedures for laboratory decontamination are outlined and possible use of common detergents discussed.

L. R. SHEPHERD

CHEMICAL ANALYSIS 543/545

545.372

2150. Preparation and testing of the electrometric adsorption element. (Potentiometric chromatography.) III. B. KAMIEŃSKI. *Bull. Int. Acad. Polonaise Sci. Lett. A, No.* 7–10, 157–60 (*Oct.–Dec.*, 1949).

An improved design of electrometric adsorption element is described [*ibid., No.* 1–4, 75, 81, 87 (1949)] which eliminates any alteration in position of the Hg drop making contact with the Pt electrode when the element is handled; and which facilitates the addition of a drop of silicic acid (the preparation of which, by dialysis, is described) to form the adsorbing layer on the ground end of the element. The element is tested by plotting potential-time curves when it is held 6 cm above a filter paper saturated with 98% AcOH and then above 1 g of Am_2CO_3, in diffuse light. A typical curve, showing the potential changes, is reproduced.

J. GRANT

545.372

2151. Electrometric selective adsorption. The antimony electrode. (Potentiometric chromatography.) IV. B. KAMIEŃSKI. *Bull. Int. Acad. Polonaise Sci. Lett. A, No.* 7–10, 171–82 (*Oct.–Dec.*, 1949).

Further improvements in design of the author's electrometric adsorption element (see preceding Abstr.) are described, including an Sb micro-electrode which is more strictly reversible than, and in other respects as satisfactory as, the quinhydrone electrode. Applications of the method to the detection of cinchonidine or caproic acid in C_6H_6 solution, to indicate the presence of AcOH or Am_2CO_3 vapours and the odours of pepper or tea, and to Tswett's classical chromatography of leaf pigments, are illustrated by potential-time curves. If the inner glass tube of the element is filled with Zn, Sb, Sn, Cd or Bi and a solution containing a mixture of different cations is poured down the adsorbing column, then the selective adsorption of the constituents enables them to be detected potentiometrically, instead of by development with chemical reagents as is usual. J. GRANT

545.822

2152. Quantitative spectrographic analysis of zirconium-hafnium mixtures. V. A. FASSEL AND C. H. ANDERSON. *J. Opt. Soc. Amer.*, **40**, 742–7 (*Nov.*, 1950).

A spectrographic method for the analysis of Zr–Hf mixtures covering the Hf/Zr concentration-ratio range from 0·001 to 100 is described. The samples are excited as conducting pellets prepared from mixtures of the combined oxides with powdered flake graphite. An overdamped condenser discharge is used for excitation. By utilizing a series of internal standard line pairs, the complete concentration range can be covered by a single exposure. At the same time, photographic photometry errors can be reduced by restricting the intensity ratio range over which these line pairs are measured. The unique similarity in the physical and chemical properties of Zr and Hf, combined with the use of line pairs of similar excitation characteristics, provides a system in which ideal internal standard conditions can be achieved. Experimental results indicate that, within the wide limits investigated, variations in excitation conditions, extraneous elements, graphite-oxide ratio in the pellets, crystal structure of the oxides, and chemical form of the samples, have no apparent effect on the analytical results. Precision determinations showed a standard deviation of about 1·5 to 2·0%. A.

545.822

2153. Simultaneous recording of two wave-length ranges with the Littrow spectrograph. R. W. MURPHY AND H. K. HUGHES. *J. Opt. Soc. Amer.*, **40**, 779–81 (*Nov.*, 1950).

Radiation incident on the upper half of the prism-lens aperture receives the dispersion and collimation to produce the normal u.v. spectrum on the photographic plate. A system of two mirrors, interposed before the lower half-aperture, provides an additional angular deviation and increase in path length to produce a visible spectrum adjacent to the u.v. spectrum. The instrument was designed for use with a Bausch and Lomb large Littrow spectrograph. Its purpose is to record, in one exposure, a spectral range sufficient for the detection and semi-quantitative estimation of all the elements, except B, which can be excited in an arc. Through the use of the auxiliary unit, the range 2 530 to 3 500 Å and any 4 000 ångstroms between 3 540 and 10 000 Å are covered in one exposure, including, for example, the four P lines and the K lines at 7 665 and 7 699 Å. A.

545.827

2154. Mass spectrograph for the rapid analysis of gas mixtures. J. TAIEB. *Onde Elect.*, **30**, 458–61 (*Nov.*, 1950) *In French.*

This instrument makes it possible to observe on the screen of a c.r.t. the result of the gas analysis. The curve displayed is called the mass spectrum of the gas in question. At atmospheric pressure even a fraction of a mm^3 of a gas mixture is sufficient for the analysis, which can be carried out almost instantaneously. This spectrograph permits of detecting isotopes and its great sensitivity makes it a useful leakage detector.

W. SUMMER

545.827

2155. Total ionization of hydrocarbons from mass spectral data. F. L. MOHLER, L. WILLIAMSON AND H. M. DEAN. *J. Res. Nat. Bur. Stand., Wash.*, **45**, 235–8 (*Sept.*, 1950).

The total ionization is computed by adding all the mass peaks in the spectrum and multiplying by the sensitivity (current per unit pressure) for the maximum peak. This is divided by the corresponding product for *n*-butane to obtain a relative value independent of the units used. Data are taken from the API Catalogue of Mass Spectral Data using revised values of sensitivity obtained by measuring pressure with a micromanometer. Total ionizations of all the isomers of a compound are nearly equal with only a few values differing greatly from the mean value. This is true in all cases where data are available for many isomers. With some exceptions total ionization increases with increasing number of C atoms in each series C_nH_{2n+2}, C_nH_{2n}, etc. Total ionization tends to decrease in compounds with the same number of C atoms and decreasing number of H atoms, but there are many exceptions. Tables summarize data for 198 hydrocarbons. Values of total ionization of isomers will in some cases permit computing all isomers as a group in chemical analysis without identifying the compounds. A.

CRYSTALLOGRAPHY 548

548.0 : 537.212

2156. Orientation of crystal nuclei of hydrated magnesium sulphate in an electric field. J. BLANDIN. *C.R. Acad. Sci., Paris*, **231**, 828–9 (*Oct.* 23, 1950) *In French.*

Crystal nuclei of $MgSO_4$, $7H_2O$ are orientated with their greatest length perpendicular to the applied electric field. Crystalline compounds with a smaller electrical anisotropy do not exhibit this effect.

W. R. ANGUS

548.0 : 539.32 : 534.13

2157. Elastic compliances of ammonium arsenate. A. LUTZ, J. CHAPELLE AND N. DELANNOY. *C.R. Acad. Sci., Paris*, **231**, 1153–5 (*Nov.* 20, 1950) *In French.*

The compliances were deduced from the observed fundamental frequencies of X- and Z-cut crystals, the following values being obtained: $S_{11}^E = 1{\cdot}69 \pm 0{\cdot}03$, $S_{12}^E = 1{\cdot}73 \pm 0{\cdot}15$, $S_{13}^E = 1{\cdot}11 \pm 0{\cdot}01$, $S_{33}^E = 4{\cdot}45 \pm 0{\cdot}04$, $S_{44}^E = 15{\cdot}29 \pm 0{\cdot}2$, $S_{66}^E = 12{\cdot}40 \pm 0{\cdot}05$ (all $\times 10^{-12}$). The temperature coefficient of a Z-cut crystal did not fall to zero in the range +64 to −42°C. H. J. H. STARKS

548.24 : 539.42

Influence of twinning on the brittle failure of zinc crystals. *See Abstr.* 2108

548.5

2158. The determination of the rates of outward growth of the faces of optically anisotropic crystals. R. MOSEBACH. *Z. Naturforsch.*, **5a**, 504–7 (*Sept.*, 1950) *In German.*

A method is described for measuring the rate of crystal growth in a direction perpendicular to a given face by compensating for the phase change produced in a beam of polarized light passing through the crystal. A polarizing microscope is used, and removal of the growing crystal from the mother liquor is unnecessary. Results of experiments on copper sulphate and potassium dichromate are given.

M. R. HOPKINS

548.5

2159. Formation of annealing twins during grain growth. R. L. FULLMAN. Letter in *J. Appl. Phys.*, **21**, 1069 (*Oct.*, 1950).

Annealed metals and alloys with face-centred cubic crystal structures frequently contain many crystals having a twinned orientation relative to the grains in which they appear. It is suggested that an annealing twin forms in the corner of a growing grain, when the orientation relationships between the twin and the surrounding grains lead to a smaller interfacial free energy than the orientation relationships between the grain itself and its neighbours. J. A. FRANKS

548.5 : 539.24

2160. Microscopical-optical research into the growth phenomena of crystals in supersaturated solutions under directed pressure. R. MOSEBACH. *Z. Naturforsch.*, **5a**, 508–13 (*Sept.*, 1950) *In German.*

With a method described in the previous paper [Abstr. 2158 (1951)] crystal growth in solutions of K_2SO_4, $K_2Cr_2O_7$ and $K_3Fe(CN)_6$ is observed. The relation $vP = RT \ln (c/c_s)$ is tested on these crystals. This method allows observation of growth of crystal planes normal or perpendicular to the direction of the pressure. C. TURNER

MOLECULAR AND X-RAY CRYSTALLOGRAPHY 548.7

548.7

2161. Orientation-translation waves in molecular crystals. III. Proper frequencies and selection rules for molecular crystals. N. N. PORFIREVA. *J. Exp. Theor. Phys., USSR*, **20** (*No.* 2) 97–107 (1950) *In Russian.*

Group theory is applied to definite models of 2- and 3-dimensional molecular crystals to determine limiting frequencies of orientation-translation waves. The kinetic and potential energies are stated in terms of elastic forces using Cartesian co-ordinates and angles and also in terms of symmetrical co-ordinates. Proper frequencies and selection rules follow from the resulting identities. The cases treated are: plane square lattice with non-polar molecules along the sides of squares; plane rhombic lattice with polar molecules arranged alternately along the sides of rhombs (4 molecules per unit cell) and a 3-dimensional stack of sheets of molecules, each as in the first example. For previous parts see Abstr. 5113 (1949) and 2769 (1950). A. L. MACKAY

548.7

2162. The relation between compressibility and resonant frequency of polarization oscillations in an ionic crystal. V. I. Odelevskiĭ. *Izv. Akad. Nauk, SSSR, Ser. Fiz.*, **14** (*No.* 2) 232–44 (1950) *In Russian.*

Only true ionic crystals of the cubic class (exemplified by NaCl, CsCl and CaF_2) are considered. The polyhedron of anions surrounding a cation or vice versa is taken as the elementary vibrator. Its equation of motion under quasi-elastic restoring forces, damping and a polarizing field is solved to give the amplitude and frequency of the oscillation, the polarizability of the polyhedron and hence the volume polarizability which is compared with the Lorenz–Lorentz equation. The proper frequency is obtained in terms of dielectric susceptibilities and atomic constants. The transmission of light through thin slices of NaCl is shown theoretically to have a minimum at approx. the proper frequency and the frequency of residual rays to be simply related to the proper frequency. Values of the resonance wavelength found by the two methods agree to within 1–2%. The lattice energies due to the various interatomic forces as calculated by Born are used to give the coefficient of quasi-elastic force on polarization of the elementary polyhedron. The bulk modulus is then derived in a form involving the proper frequency. Information on the rate of change of repulsion between like and unlike ions is obtained which agrees satisfactorily with experiment.

A. L. MACKAY

548.7

2163. Gallium anisotropy and crystal structure. R. W. Powell. Letter in *Nature, Lond.*, **166**, 1110–11 (*Dec.* 30, 1950).

548.733

2164. Orientation of crystals using a Geiger counter X-ray spectrometer. J. A. James. *J. Sci. Instrum.*, **27**, 326 (*Dec.*, 1950).

A Geiger counter X-ray spectrometer is described which enables orientation of single crystals, or large crystals in polycrystalline sheet, to be carried out rapidly without special preparation of the sample. A.

548.733

2165. The setting of single crystals from zero layer curve photographs. P. T. Davies. Letter in *J. Sci. Instrum.*, **27**, 338 (*Dec.*, 1950).

An improvement and simplification of an earlier method [Abstr. 2626 (1948)]. A.

548.734.2

2166. X-ray investigation of the nuclear spot of crystals obtained by recrystallization. T. J. Tiedema. *Proc. K. Ned. Akad. Wet.*, **53** (*No.* 9) 1422–5 (1950).

The lattice orientation within single crystals in rolled and annealed Al sheet was investigated by ordinary Laue photographs and by Guinier and Tennevin's variant of Laue's method [Abstr. 5124 (1949)]. Results show a nuclear spot with orientation deviating by $\sim 1°$ from that of the main body of the crystal, and the division of the main body into two or more regions with orientations differing by $\sim 20'$.

A. R. STOKES

548.734.3

2167. A diamond bomb for obtaining powder pictures at high pressures. A. W. Lawson and T.-Y. Tang. Note in *Rev. Sci. Instrum.*, **21**, 815 (*Sept.*, 1950).

548.734.3

2168. Geiger-counter X-ray spectrometer—influence of size and absorption coefficient of specimen on position and shape of powder diffraction maxima. A. J. C. Wilson. *J. Sci. Instrum.*, **27**, 321–5 (*Dec.*, 1950).

In powder spectrometers of modern design the "vertical" divergence of the beam is limited by Soller slits, and has little influence on the position and shape of the diffraction maxima. "Horizontal" divergence cannot be considered apart from absorption and thickness of specimen. These three effects shift the centre of gravity of the maximum toward lower values of θ by

$$\frac{A^2 \sin 2\theta}{6R^2} + \frac{\sin 2\theta}{4\mu R} - \frac{t \cos \theta}{R\{\exp(2\mu t \csc \theta) - 1\}}$$

radians, where $2A$ is the illuminated length of the specimen, t is its thickness, R is the spectrometer radius, and μ is the linear absorption coefficient of the specimen. In most spectrometers A is limited by slits to $\alpha R \csc \theta$, where 2α is the horizontal divergence of the incident beam, but in some the specimen is irradiated over its full length L, and A is constant at $\frac{1}{2}L$. The shift of the peak is more complicated, and requires a consideration of the line profile. In the limiting case of θ large a first approximation gives the same displacement for the peak as for the centre of gravity; in the limiting case of θ small the peak displacement is the smallest of the three expressions

$$\frac{A^2 \sin 2\theta}{2R^2}, \quad \frac{0{\cdot}214 \sin 2\theta}{\mu R}, \quad \frac{t \cos \theta}{R}$$

No simple expression has been found for intermediate values of θ. Except for weakly absorbing substances and low Bragg angles the displacements are very small. The error in the spacings calculated from high-angle lines is discussed; there seems to be no reason why Geiger-counter spectrometry should not reach the same accuracy as the powder camera in the measurement of spacings. A.

548.734.3

2169. Effect of crystal, grain, and particle size on X-ray power diffracted from powders. Z. W. Wilchinsky. *Acta Cryst.*, **4**, 1–9 (*Jan.*, 1951).

A theoretical and experimental investigation has been made on diffraction of X-rays from crystalline powders in which the diffracted power is modified by the powder coarseness and absorption inhomogeneities in the sample. Compared with previous theories, the present theory is more extensive and has been found to fit the experimental data better. The magnitude of the diffracted power is related theoretically to particle diameter, linear absorption coefficient, degree of compaction of the powder, crystal size, primary extinction coefficient, crystal-chemical composition and grain size for polyphased particles. It is shown theoretically and experimentally that these variables can cause the diffracted power to be significantly different from that for an ideal case. For a powder of a single substance (Fe),

excellent agreement between theory and experiment has been obtained for the effects due to particle size, absorption coefficient and degree of compaction. Theoretical predictions of diffracted power from an Fe–W mixture have been substantiated experimentally. Measurements on heat-treated Fe samples show that the diffracted power decreases with increasing crystal size, and indicate that the equation for this effect might be useful in determining crystal sizes in the range 10^{-5} to 10^{-3} cm. A.

548.734.4

2170. A modified Lorentz factor for the rotating crystal method. H. G. Heide. *Acta Cryst.*, **4**, 29–34 (*Jan.*, 1951) *In German.*

The usual expressions for the Lorentz factor of rotation diagrams become infinite for certain angles. This ceases to be the case if a finite region of reflecting power is taken account of in reciprocal space, corresponding to small finite coherent blocks in the crystal. Curves are calculated showing how the reflected intensity depends on the size of these blocks and on the angle of reflection in the neighbourhood of those angles for which the usual expression is infinite. A.

548.735

2171. Accuracy of X-ray structural analysis of crystals. A. I. Kitaĭgorodskiĭ. *J. Tech. Phys., USSR*, **20**, 397–411 (*April*, 1950) *In Russian.*

The accuracy is in the main determined by the point where the series of the electron density may or must be broken off. The period of the distribution function gives the dimensions of the elementary cell, the density maxima locate the atom "centres." The ordinary technique permits of determining the lattice period to within 0·01 Å; a moderately more elaborate technique may better this by a full order of magnitude. For the simple crystals, where the atoms occupy the intersections of the symmetry axes, and have no degrees of freedom, the interatomic distances can be determined from the lattice period. Even for more complicated crystals, the necessary 2–3 parameters could be determined by 80–100 repetitions of the measurements of structure factors. But the corresponding number for molecular crystals is 20–50 parameters. An improvement of the accuracy by work at low temperatures and with hard X-rays is impossible, although the *f*-curve may be continued down to values 1/1 000 of the maximum; it is then that the reliable determination of the structural amplitudes is prohibitive. At low *f*-values, on the other hand, the deviations from the mean *f*-curve due to the anisotropy of the thermal vibrations and the existence of the chemical bond become appreciable and make determination of F impossible. Even for a simple diatomic molecule, assuming the error in the determination of f as 25%, the ambiguity of F is expressed by the extreme values $F = -2/4f$ and $F = +2/4f$. These antagonistic reflexes mark the value of αs, beyond which continuation of the series gives no further information. For organic substances continuation of the *f*-curve to values smaller than $0{\cdot}06f$ is difficult for lack of experimental data.

B. F. KRAUS

548.735.4

2172. The accuracy of electron-density maps in X-ray analysis with special reference to dibenzyl. D. W. J. Cruickshank. Note in *Acta Cryst.*, **3**, 72–3 (*Jan.*, 1950).

Corrigendum to Abstr. 2806 (1949). See also Abstr. 4040 (1948), 5133 (1949), 3520 (1950). Affects the expressions previously obtained for the standard deviation of atomic co-ordinates. A. R. STOKES

548.735.4

2173. The one-dimensional crystal. III. A punched-card method for computing structure factors. G. Donnay and J. D. H. Donnay. Note in *Acta Cryst.*, **4**, 74–5 (*Jan.*, 1951).—See Abstr. 6162–3 (1950).

548.735.46 : 548.737

2174. Interpretation of the Patterson synthesis: rubidium benzyl penicillin. J. H. Robertson. *Acta Cryst.*, **4**, 63–6 (*Jan.*, 1951).

In substances containing a heavy atom, and suitable multiplicity in the space-group symmetry, the Patterson function may be used directly by the "Vector Convergence Method," to give approximate positions of the lighter atoms in the crystal structure. The method is here illustrated by application to the case of rubidium benzyl penicillin. The 3-dimensional Patterson function has been calculated and the vectors to the penicillin molecule from the four Rb atoms in the unit cell have been studied by construction of "Vector Convergence Density" maps in 3-dimensional space. A fair degree of correlation has been found between these results and the known structure of the crystal. A.

548.736.3

2175. The crystal structure of hydrazine. R. L. Collin and W. N. Lipscomb. *Acta Cryst.*, **4**, 10–14 (*Jan.*, 1951).

Monoclinic C_{2h}^2–$P2_1/m$ with two N_2H_4 molecules in a cell of dimensions $a = 3{\cdot}56$, $b = 5{\cdot}78$, $c = 4{\cdot}53$ Å, and $\beta = 109{\cdot}5°$. The N–N bond lies in the mirror plane with N atoms at $x_1 = 0{\cdot}037$, $z_1 = 0{\cdot}362$ and at $x_2 = 0{\cdot}736$, $z_2 = 0{\cdot}050$. The N–N bond distance is 1·46 Å, and nearest non-bonded distances are 3·19, 3·25 and 3·30 Å. The structure suggests an eclipsed configuration for the hydrazine molecule in the crystal, and does not appear to permit residual entropy to be retained at low temperatures. A.

548.736.3

2176. The crystal structure of hydrogen peroxide. S. C. Abrahams, R. L. Collin and W. N. Lipscomb. *Acta Cryst.*, **4**, 15–20 (*Jan.*, 1951).

Hydrogen peroxide forms tetragonal crystals, space group D_4^4–$P4_12_1$. There are four molecules in the unit cell of dimensions $a = 4{\cdot}06$, $c = 8{\cdot}00$ Å. The crystal structure has been completely determined, using both double Fourier series and least-squares methods, based on visual intensity measurements of the reflections from three zones. The O–O bond distance is 1·49 Å, the angle made by the hydrogen bond with the O–O bond is about 97°, and the azimuthal angle between planes containing the hydrogen bonds and the O–O bond is 94°. Each oxygen atom has two close approach distances of 2·78 Å and two longer ones of 2·90 Å, resulting in a very compact crystal. Assuming hydrogen bonds in the 2·78 Å distances, no measurable retention of entropy is to be expected at absolute zero. A

mechanism for the formation of hydrogen peroxide–water solid solutions is also suggested. A.

548.736.3

2177. Confirmation of the structure of chromium boride, CrB. A. J. Frueh, Jr. Note in *Acta Cryst.*, **4**, 66–7 (*Jan.*, 1951).

548.736.4

2178. On the phase transition in lead zirconate. G. Shirane, E. Sawaguchi and A. Takeda. Letter in *Phys. Rev.*, **80**, 485 (*Nov.* 1, 1950).

548.736.4

2179. The space group of calcium peroxide octahydrate. R. S. Shineman and A. J. King. Note in *Acta Cryst.*, **4**, 67–8 (*Jan.*, 1951).

548.736.4

2180. The structure of the ferroelectric niobates and tantalates. P. Vousden. Note in *Acta Cryst.*, **4**, 68 (*Jan.*, 1951).

548.736.5

2181. The crystal structure of $Th(OH)_2SO_4$. G. Lundgren. *Ark. Kemi*, **2**, *Paper* 39, 535–49 (1950).

Orthorhombic, *Pnma* or *Pn2a* (former assumed), $a = 11{\cdot}733 \pm 5$, $b = 6{\cdot}040 \pm 5$, $c = 7{\cdot}059 \pm 5$ Å, measured density 4·7, $Z = 4$, Th in 4(*c*) with $x = 0{\cdot}064 \pm 3$, $z = 0{\cdot}148 \pm 5$ from Patterson synthesis and intensity agreement, S and O positions largely by packing. The existence of the $Th(OH)_2$ chain [Abstr. 2785 (1950)] is confirmed. A. J. C. Wilson

548.736.5

2182. The crystal structure of *trans* potassium dioxalatodiaquo-chromiate $K[Cr(C_2O_4)_2(H_2O)_2].3H_2O$. J. N. van Niekerk and F. R. L. Schoening. *Acta Cryst.*, **4**, 35–41 (*Jan.*, 1951).

548.736.6

2183. The structures of the plagioclase felspars. I. W. F. Cole, H. Sörum and W. H. Taylor. *Acta Cryst.*, **4**, 20–9 (*Jan.*, 1951).

548.737

2184. Length of central bond in thiophthen. H. C. Longuet-Higgins. Note in *Acta Cryst.*, **3**, 76 (*Jan.*, 1950).

548.737

2185. A note on the diffraction patterns of crystalline proteins. D. Wrinch. Note in *Acta Cryst.*, **3**, 76–7 (*Jan.*, 1950).

548.737

2186. The quantitative determination of the crystallinity of polyethylene as a function of temperature. J.-J. Trillat, S. Barbezat and A. Delalande. *C.R. Acad. Sci., Paris*, **231**, 853–5 (*Oct.* 23, 1950) *In French.*

X-ray diffraction diagrams of a sample of polyethylene (m.w. = 15 000 approx.) were taken at various temperatures up to 120°C. This material is partly crystalline and partly amorphous. The latter part gives a diffuse halo of intensity I_A while from the former part Bragg reflections (110) and (200) are obtained of intensity $I_{(110)}$ and $I_{(200)}$. It is found that the ratio W_A/W_C (W_A is the mass of amorphous material, W_C is the mass of crystalline material) can be represented by the ratio $I_A/I_{(110)} + I_{(200)}$. The intensities are measured with a microdensitometer and the values of $W_A/W_A + W_C$ are calculated for each temperature and the curve relating the values to temperature is plotted. The curve so obtained is in fair agreement with the one obtained by other workers using other properties to determine $W_A/W_A + W_C$ [Abstr. 1490 (1945)]. J. Iball

548.737

2187. The crystal structure of cysteylglycine-sodium iodide. H. B. Dyer. *Acta Cryst.*, **4**, 42–50 (*Jan.*, 1951).

548.737

2188. The configurations of the diastereomeric 1 - chloromercuri - 2 - methoxycyclohexanes. A. G. Brook and G. F. Wright. *Acta Cryst.*, **4**, 50–8 (*Jan.*, 1951).

548.737

2189. A refinement of the crystal structure analysis of β-isoprene sulphone. G. A. Jeffrey. *Acta Cryst.*, **4**, 58–63 (*Jan.*, 1951).

The previous results of the crystal structure analysis of *β*-isoprene sulphone [Abstr. 2481 (1942)] have been corrected for the termination-of-series errors. These corrections are considerable, producing changes in the atomic co-ordinates up to 0·06 Å and comparable amendment of the interatomic distances. The new C–C bond lengths are 1·47 Å for the two formal single bonds and 1·38 Å for the double bond. The mean C–S bond length is 1·74 Å, and the S–O bond length is 1·44 Å. A calculation of the standard deviation of these values indicates that with the exception of the S–O and C–C double bond lengths they are significantly different from the bond lengths associated with the normal representation of the molecule. There is some evidence to show that methylene groups are often "activated" by adjacent sulphone groups, and the shortening of the formal single bonds may be a general feature of such molecules; but further experimental evidence is necessary. A.

548.74 : 537.533.73

2190. Dynamic dispersion of electrons. Z. G. Pinsker and B. K. Vaĭnshtein. *Izv. Akad. Nauk, SSSR, Ser. Fiz.*, **14** (*No.* 2) 212–22 (1950) *In Russian.*

The problem, prominent in X-ray structural analysis, of the relation between kinetic and dynamic dispersions of short waves in crystals leads the author to calculations of absolute intensities in the diffraction of electrons. The expressions obtained show that such data are necessarily orientated. Experimental results are illustrated by (1) a series of photo-prints of electrograms showing secondary reflections from, e.g., oxidized Cu and Ag, (2) a diagram of secondary reflections, (3) a table of determination of Cu reflections (200) and (220) in cases of dynamic dispersion. It is concluded that diffraction intensities in such cases are proportional, in a wide range of salts and metals, to integral reflection. J. Cleugh

GEOPHYSICS 55

550.2

2191. Contribution to the problem of solar influence on geophysical events. M. PAUL. *Geofis. Pura Appl.*, **17**, 13–36 (*July–Sept.*, 1950) *In German.*

Diagrams are given to show that magnetic storms and earthquakes are connected with a period of 34·19 days. This was the period previously given by the author in *Gerlands Beiträge zur Geophysik*, vol. 44 (1935) in his theory of the rotation of a hypothetical sun-core. A. BEER

550.361

2192. The temperature-gradient at the Earth's surface and the radioactive heat production in the Earth's crust taking into account the half-lives. K. JUNG. *Geofis. Pura Appl.*, **17**, 1–12 (*July–Sept.*, 1950) *In German.*

On the assumption that (1) the radioactive heat generation is constant in a superficial layer of thickness H, and that no radioactive heat is generated in deeper layers, or (2) the radioactive heat generation at the depth z is proportional to $e^{-\alpha z}$, H. Jeffreys had computed that H and $1/\alpha$ are about 13 km. He took an initial temperature which varied linearly with z, and did not take into account the loss of radioactive substances by disintegration. The author takes an initial temperature which, with increasing z, approaches a fixed value, and by considering the half-lives of radioactive elements obtains the values $H = 23$ and $1/\alpha = 20$ km. New results by Bullard indicate that radioactive heat generation in rocks is less than was accepted until now; with his results values of 45–50 km for H and $1/\alpha$ are possible. A. BEER

550.93 : 539.155.2

2193. Dating the past by radioactive carbon. F. E. ZEUNER. *Nature, Lond.*, **166**, 756–7 (*Nov.* 4, 1950).

Carbon 14 produced by cosmic rays in the atmosphere and synthesized into living tissues provides a time scale back to 20 000 years. A critical study of this method of dating is given. F. T. FARMER

550.93 : 539.155.2

2194. Comparison of archæological and radiocarbon datings. V. G. CHILDE. Letter in *Nature, Lond.*, **166**, 1068–9 (*Dec.* 23, 1950).

ATMOSPHERE . METEOROLOGY 551.5

551.508 : 697 : 621.317.39

2195. Some meteorological instruments used in building research. A. W. PRATT, B. G. COLLINS, R. E. LACY AND E. W. SPINK. *Instn Elect. Engrs, Paper* 1105, 6 *pp.* [*Early Proof Issue*].

Describes four electrically operated meteorological instruments, traces the reasons for their development and gives some examples of the uses to which they are put. The first instrument—a wind-run analyser—records the run of wind over successive time intervals which may be varied from 5 min to 1 hr. The wind-direction recorder shows, on meters, the run of wind over any desired period, from each of 8 directions. The third instrument, an equivalent-air-temperature recorder, measures the equivalent temperature to which walls of various orientations are exposed, taking into account air temperature, radiation and air movement. The fourth is a temperature-integrating-and-averaging device, from which the mean temperatures of the preceding period may be read directly. A.

551.508.19 : 621.317.083.7 : 621.396.91

2196. The radar-sonde system for the measurement of upper wind and air data. F. E. JONES, J. E. N. HOOPER AND N. L. ALDER. *Instn Elect. Engrs, Paper* 1095, 9 *pp.* [*Early Proof Issue*].

Describes a new system of meteorological sounding employing secondary-radar principles. Pressure, temperature and humidity are each telemetered to an accuracy of $\frac{1}{1000}$ part of their operating range, although the elements at present used may not be capable of measuring the meteorological parameters to this degree of accuracy. In addition, wind speed and direction are automatically measured. The maximum slant range of the system is about 100 miles, and thus the height to which soundings and wind measurements can be made is, at present, largely limited by the height at which the balloon carrying the instruments bursts. A.

551.508.25

2197. New standards for Landsberg's glass rod method of integrating ultraviolet radiation. J. SHERROD, H. NEUBERGER AND D. YERG. *Trans Amer. Geophys. Un.*, **31**, 696–8 (*Oct.*, 1950).

551.508.29

2198. Investigation of the effect of radiation on small platinum wire resistance thermometers with a cellon glass frame. W. GEISS. *Z. Met.*, **3** (*No.* 11–12) 356–8 (*Nov.–Dec.*, 1949) *In German.*

Six Pt wires 0·02 mm dia. were stretched on a frame holding a glass shield ½ mm thick. Resistance 108 ohm at 20°C. Two such thermometers were exposed, one in shade and one in sun. Difference of temperature did not exceed 0·5°C on a hot still day, so that practically no radiation error existed. METEOROLOGICAL ABSTRACTS

551.508.5 : 621.317.39

2199. Mean-wind-velocity instruments for use on naval craft. J. BELL AND E. M. LANGHAM. *Instn Elect. Engrs, Paper* 1103, 5 *pp.* [*Early Proof Issue*].

Describes two instruments made for use on naval craft during 1939–45. The first was fitted to auxiliary aircraft carriers, and indicated the mean wind direction, so that the vessel might be steered correctly for the take-off and landing of aircraft. The second instrument was fitted on larger naval craft, for meteorological purposes. Its function was to indicate, in various positions in the ship, the direction and speed of both the mean true and the mean apparent winds. The components used in both instruments are magslip transmission elements and electrical computing devices, which were developed for fire-control purposes and subsequently adopted for the meteorological applications. A.

551.508.71 : 621.317.39

2200. An automatic frost-point hygrometer for measurements in the upper air. A. W. Brewer and R. H. Dobson. *Instn Elect. Engrs, Paper* 1104, 4 *pp.* [*Early Proof Issue*].

The mutually operated frost-point hygrometer and a frost-point hygrometer employing photo-electric indication of the dew or hoar-frost deposit, have both shown their value as meteorological instruments; both can measure absolute humidities as low as 1 mg/m^3, corresponding to a frost point of − 80°c. To reduce the observational skill required, a fully automatic hygrometer was developed; the conditions which the automatic instrument must fulfil are outlined and some of the special difficulties are discussed. A brief description is given of an instrument which has fulfilled laboratory tests and will measure any frost point from room temperature to − 80° c. Operation below about + 80°c is impossible, owing to the slow rate of crystal growth at such temperatures. A.

551.510.5

2201. Upper atmospheric nomenclature. S. Chapman. *J. Atmos. Terr. Phys.*, **1** (*No.* 2) 121–4 (1950). Also *J. Geophys. Res.*, **55**, 395–9 (*Dec.*, 1950).

For abstract see Abstr. 1535 (1951).

551.510.535

2202. Studies of the F_2 layer in the ionosphere. I. The position of the ionospheric equator in the F_2 layer. E. Appleton. *J. Atmos. Terr. Phys.*, **1** (*No.* 2) 106–13 (1950).

The seasonal variations of the noon equivalent heights of the F_2-layer at a number of stations are examined and the variations characteristic of the northern hemisphere and of the southern hemisphere identified. It is shown that the change-over from one type of variation to the other occurs in a region which is more nearly coincident with the magnetic equator than with the geographical equator. A.

551.510.535

2203. A survey of recent ionospheric measurements at the ionospheric and radio wave propagation observatory at Kiruna. R. Lindquist. *Ark. Geofys.*, **1**, *Paper* 11, 247–66 (1951).

Gives some preliminary results obtained from the recordings during the period October 1948–August 1949. Different types of sporadic *E* echoes are classified and the diurnal and seasonal behaviour of *Es* is shown and discussed. The relation between *Es* and magnetic disturbances is further discussed. A few typical polar black-outs are described and studied. The diurnal and seasonal behaviour of the ordinary layers is also shown as a final bi-product. A.

551.510.535

2204. Corpuscular influences upon the upper atmosphere. S. Chapman. *J. Geophys. Res.*, **55**, 361–72 (*Dec.*, 1950).

The evidence for the corpuscular theory of magnetic storms and aurorae is briefly reviewed. No certain success has attended the efforts made to detect the solar corpuscles during their emission from the sun or their passage to the earth; recent observations of atomic hydrogen lines in the auroral spectrum, which are broadened and displaced by Doppler effect, give the most direct support yet available to the corpuscular theory. A.

551.510.535

2205. Recombination and attachment in the *F*-region during the eclipse of May 20, 1947. J. Savitt. *J. Geophys. Res.*, **55**, 385–94 (*Dec.*, 1950).

The variations of electron density during the solar eclipse of May 20, 1947, for fixed heights in the *F*-region of the ionosphere are compared with the variations expected under alternative assumptions that the disappearance of elecrons is by recombination and by attachment. The recombination and attachment coefficients deduced vary systematically with height and are consistent with those obtained by other investigations. The best agreement of observation and theory is obtained with the data for 260 km assuming an attachment process. A.

551.510.535

2206. The lowest of the ionized layers of the upper atmosphere. D. Stranz. *Tellus*, **2**, 150–7 (*Aug.*, 1950).

The "Stockwerk-Gliederung" of the earth's atmosphere is discussed. The region above the upper inversion (at ca. 75 km) up to 100 km height is generally called the D-layer, which means the lowest of the ionized regions in the upper atmosphere of the earth. The behaviour of the D-layer, its most reasonable theory of formation, and its function with regard to the propagation of electromagnetic waves are discussed. Features related to solar-terrestrial phenomena are shown. Theories and ideas by various authors are compared with each other. A.

551.510.535 : 621.317.39 : 621.396.11

2207. An automatic ionospheric recorder for the frequency range 0·55 to 17 Mc/s. R. Naismith and R. Bailey. *Proc. Instn Elect. Engrs, Pt III*, **98**, 11–18 (*Jan.*, 1951) [*Reprint No.* 1010].

The servo-electric ionospheric recorder in use at the Radio Research Station, Slough, is described in relation to its general use for routine recording purposes. It contains 5 essential parts: (*a*) a pulse transmitter, (*b*) a pulse receiver, (*c*) a servo-electric control working through a discriminator to keep the receiver in tune with the transmitter, (*d*) a calibration unit and (*e*) a recording unit. This type of equipment has been in continuous use for over six years, producing hourly records of ionospheric conditions; the record consists of a graph of equivalent height of reflection of radio waves as a function of frequency. The height and frequency graticules are produced simultaneously with the echoes, and the date and time of the observations are recorded automatically. A.

551.513

2208. Geostrophic departures in the jet stream. V. P. Starr. *Tellus*, **2**, 233–5 (*Aug.*, 1950).

The effect of gradients in the cross-current eddy motions on the geostrophic balance is illustrated by means of an integrated model. It is suggested that gradients of the Reynolds stress associated with such eddy motions in the atmosphere and in the oceans may lead to sensible average geostrophic departures which appear as a normal inertial effect in eddying currents. A.

551.515.7

2209. Experimental studies of a polar vortex. I. D. Fultz. *Tellus*, **2**, 137–49 (*Aug.*, 1950).

A description is given of experiments designed to produce phenomena exhibiting effects of the resultant horizontal Coriolis force on a symmetrical vortex that results from the latitude variation of the Coriolis force. A circular cap of dense liquid at the base of a small hemispherical shell filled with liquid was forced to rotate about a vertical axis independently of the rate of rotation of the remaining fluid and containing vessels. Within the ranges of 20 to 150 r.p.m. for the vessel and 0 to 120 relative r.p.m. for the cap vortex, the centre of mass of the polar cap never showed appreciable displacements away from the polar axis except for a range of sufficiently high relative rotations when the vortex was anticyclonic in sense. Numerical checks are given with a simplified calculation in spherical co-ordinates of the torque equilibrium for the vortex as a whole. A.

551.521.3 : 551.510.5

2210. The effect of pressure broadening of spectral lines on atmospheric temperature. J. Strong and G. N. Plass. *Astrophys. J.*, **112**, 365–79 (*Nov.*, 1950).

Pressure broadening causes lines in i.r. absorption bands to have considerably greater half-widths in the lower layers of a planetary atmosphere than in the upper layers. As a result, radiation emitted upward from the wings of lines in the lower atmosphere is not strongly absorbed by the upper layers. Such radiation is thus free to escape to the cosmic cold. The net loss of heat by radiation from the various layers in the stratosphere is calculated and is greater for the lower layers than for the upper layers. This affords a new basis for the explanation of the existence of the stratosphere. The radiation budget for the stratosphere as a whole is reconsidered after these ideas and after new data on the transmission of the upper air first published herein. It is shown that the heat losses from the stratosphere by radiation from the 9·6 μ O_3, 15 μ CO_2 and 50 μ H_2O bands are approximately balanced by the heat gained from absorption of terrestrial radiation by these bands and by the absorption of solar radiation by O_3 in the u.v. A.

551.524.7 : 551.593.55

2211. Tentative determination of the temperature of the higher layer of the terrestrial atmosphere from observations of the brightness of the twilight arc. N. M. Shtaude. *Dokl. Akad. Nauk, SSSR*, **74** (*No.* 4) 703–15 (1950) *In Russian.*

551.571.4

2212. Vertical distribution of atmospheric humidity near the ground. N. K. Johnson. Letter in *Nature, Lond.*, **167**, 109 (*Jan.* 20, 1951).

551.574.1 : 539.27

2213. Preliminary investigation of condensation nuclei under the electron microscope. C. L. Hosler. *Trans Amer. Geophys. Un.*, **31**, 707–10 (*Oct.*, 1950).

Condensation nuclei have been examined and photographed in the electron microscope. The apparatus used and the technique employed to prepare specimens are described. Preliminary electron-photomicrographic investigations into the nature of condensation nuclei have demonstrated several important facts. Measurements of nuclei which were photographed and calculations of the mass of the nuclei, give figures in good agreement with those obtained by other authors by indirect means. However, the nuclei counts made using the electron microscope indicate that those taken with an Aitken counter do not even closely approximate the total number of nuclei. The majority of nuclei seem to be of such small size that the droplets formed on them are not visible in the Aitken counter. Using the electron microscope the nuclei can be examined for their structure and form. This enables study of different types of nuclei and the properties which determine the degree of supersaturation required for condensation on them. A.

551.574 : 548.5

2214. On the rate of nucleation of ice. H. Oura. Note in *J. Phys. Soc. Japan*, **5**, 277–9 (*July–Aug.*, 1950).

The experiments of Johannsen and Schaefer showed that nuclei, consisting of tiny ice crystals, can be produced spontaneously in supercooled water or air. Using Turnbull and Fisher's equation, the rate of nucleation has been determined. The interfacial free energy between ice and water and between air and ice was calculated. The results of Johannsen and Schaefer's experiments are explained qualitatively.

R. S. READ

551.576 : 534.23

2215. Behaviour of a sound wave when passing through a cloud layer. G. Zanotelli. *Ann. Geofis.*, **3**, 289–301 (*July*, 1950) *In Italian.*

The propagation through air containing uniformly distributed droplets of equal radius, taking into account the viscosity of the air and the motion of the droplets, is discussed. With low frequencies small droplets vibrate but with high frequencies the larger droplets remain stationary. In the first case the greatest values of the extinction coefficient are obtained while in the second the refraction index is the greater.

M. DOPORTO

551.578.11 : 539.16

2216. On the radioactivity of atmospheric precipitates. A. Stefanizzi. *J. Geophys. Res.*, **55**, 373–8 (*Dec.*, 1950).

The radioactivity of the atmospheric precipitates (snow and rain) was determined in 33 cases. It was found that snow usually has a greater activity than rain; that rain in thunder-showers is more active than ordinary rain; and that at least a certain amount of activity is acquired by precipitates during their fall from the clouds to the ground level. It was also possible to ascertain the presence of decay products of thoron in precipitates. A.

551.583

2217. Latest discoveries of main weather features. F. Baur. *Scientia*, **85** (*No.* 10) 241–51 (1950) *In German.*

By main weather features are intended those which persist for a few days apart from the smaller changes with place and time. Their existence is first demonstrated and singularities and points of symmetry are dealt with. The causes of individual oscillations of these features within the sunspot cycle, the double oscillation of these features in the temperate zones

and the importance of solar faculae are examined. The weather features associated with main pressure distributions in Europe and the North Atlantic are shown, and also the effect of accidental frequency peaks in the changes. R. S. READ

551.583.13

2218. The 8-year climatic cycle and its physical reality. S. POLLI. *Ann. Geofis.*, **3**, 63–76 (*Jan.*, 1950) *In Italian.*

As a result of an examination of over 50 investigations of periodicities of different climatic and geophysical elements the author considers that the 8-year period is a physical reality. M. DOPORTO

551.593.12

2219. Scattering of electromagnetic waves by atmospheric turbulence. E. C. S. MEGAW. *Nature, Lond.*, **166**, 1100–1 (*Dec.* 30, 1950).

Stellar scintillation and atmospheric turbulence are briefly discussed and an outline given of a study of the relation between the two phenomena. The results indicate that observations of stellar brightness fluctuations are consistent with an average spectrum of turbulence which is a permanent character of the atmosphere. References are given to the particular type of spectrum [Kolmogoroff, *Dokl. Akad. Nauk, SSSR*, **30**, 301; **32**, 16 (1941)] assumed.

W. J. G. BEYNON

551.593.55

2220. Progress in studies of the airglow in upper air research. C. T. ELVEY. *Amer. J. Phys.*, **18**, 431–7 (*Oct.*, 1950).

Results to date of a co-operative programme sponsored by the Office of Naval Research, U.S.N., are summarized. The work undertaken includes spectrophotometry of the various emissions from the upper atmosphere with spectrographs and photoelectric photometers (the latter fully automatic, and recording). A study has been made of the light scattered from the sunlit, zenith sky during early and late twilight, range of solar Z.D., 90°–108°. The presence of H (Balmer) emissions in the airglow spectrum has been established, and may be due to distant aurorae. Photometry of the green (OI) and yellow (D) Na lines show that their average intensities correspond to 5×10^8 and 8×10^7 quanta/cm² sec at altitudes close to E and F night regions of the ionosphere respectively. Resonance radiation from Na atoms has been detected up to heights of 800 km at twilight. The band of uncertain origin at 6 560 Å in the night-sky spectrum, previously reported by Elvey and Farnsworth (1942) is now found to be spurious. A new line at 6 847 Å has been detected, whose intensity is comparable to those of the OI lines at 6 300 and 6 364 Å: identity has not yet been established.

D. R. BARBER

551.593.7

2221. The spectral distribution of polarization in sky light. R. CIALDEA. *Ann. Geofis.*, **3**, 357–70 (*July*, 1950) *In Italian.*

Observations of the degree of polarization of light from the sky show 3 typical conditions, with the polarization increasing, constant or decreasing with wavelength. Theory shows that this relationship depends upon the ratio of (*a*) scatter from particles of molecular size, (*b*) diffuse scatter from layers of large particles, the thickness of these layers determining the type of spectral distribution. R. W. FISH

551.593.7

2222. Polarization of the sunlit sky. S. CHANDRASEKHAR AND D. ELBERT. *Nature, Lond.*, **167**, 51–5 (*Jan.* 13, 1951).

A brief account is given of earlier work on the illumination and polarization of the sky. Particular reference is made to the neutral points and lines of Babinet, Brewster and Arago. Rayleigh's laws of scattering are not sufficient to account for phenomena of sky radiation which are due to the admixture, in the observed light, of light which has suffered multiple scattering. A theory for such phenomena involves a knowledge of the best way in which a general partially polarized radiation field can be characterized so that the exact equations of the problem can be correctly formulated, and the formulation of a basic problem the solution of which will provide a simple, convincing explanation of neutral points and lines. This theory has been given recently (*Radiation Transfer*, S. Chandrasekhar, Oxford, 1950) and this article gives further details and shows that theory and observation agree. The results also show that the position of the neutral points are not affected by ground reflection, but the degree of polarization is affected. Graphs are drawn to illustrate the results, including one showing the variation of degree of polarization at the zenith with angle of incidence. H. G. JERRARD

551.594.5

2223. Observations of the aurora borealis. D. BARBIER AND D. R. WILLIAMS. *J. Geophys. Res.*, **55**, 401–14 (*Dec.*, 1950).

From spectrograms obtained near Fairbanks, Alaska, identifications of lines and bands in the spectral range from 3 100 Å to 5 000 Å are proposed. The presence of the heretofore debatable lines, NI 3467 and OI 4368, is confirmed. The observed intensity distribution in the Vegard–Kaplan system in the aurora is entirely different from that in the night sky. Several weak spectrograms in the region 6 300 Å to 6 900 Å are discussed. Visual observations of auroral phenomena are set forth and include a detailed description of a blue, sunlit aurora. A.

551.593.9

2224. Theoretical considerations regarding the altitude of the layer responsible for the nocturnal emission of the sodium *D*-lines. D. R. BATES AND M. NICOLET. *J. Geophys. Res.*, **55**, 235–9 (*Sept.*, 1950).

The altitude of the layer responsible for the nocturnal emission of the *D*-lines is discussed theoretically. General arguments are used to show that if the luminosity originates directly from atmospheric sodium, its location must be far lower than is indicated by the recent observations of Barbier and Roach. Should these prove to be even approximately correct, some other source would apparently have to be invoked. A.

551.593.9

2225. O_2 emission bands in the infrared spectrum of the night sky. A. B. MEINEL. *Astrophys. J.*, **112**, 464–8 (*Nov.*, 1950).

A study of the profile of the (0, 1) 8 645 Å band of

the atmospheric $^1\Sigma - {}^3\Sigma$ system of O_2 has indicated a normal rotational temperature of $150° \pm 20°$ K. A temperature of $200° \pm 10°$K was obtained from a spectrogram that recorded a strong enhancement of this band on December 29, 1949. The temperature and a comparison with the OH emission bands places the O-emission stratum at 80 km. A.

551.593.9 : 551.510.41

2226. A suggestion regarding the use of rockets to vary the amount of atmospheric sodium. D. R. BATES. Letter in *J. Geophys. Res.*, **55**, 347–9 (*Sept.*, 1950).

Assuming that the nocturnal emission is caused by some chemical reaction, observed intensities and deduced atomic concentrations enable an estimate to be made of the intensity of emission from a 100 g cloud ejected from a rocket at a height of 70 km during the nocturnal and twilight periods; the integrated stellar magnitudes are found to be — 4 and — 9 respectively, indicating a luminosity sufficient for quantitative measurement. Some suggestions about the type of information which could be so obtained are made. M. W. OVENDEN

551.594.11

2227. On diurnal variation of the atmospheric electric potential gradients. H. ISRAËL. *Met. Rdsch.*, **1** (*No.* 7–8) 200–4 (*Jan.–Feb.*, 1948) *In German.*

The time of nocturnal minimum of potential gradient in the atmosphere is nearly constant (3–5 a.m.) throughout the year, but the morning and evening maxima change time with the seasons suggesting a relation between turbulent exchange and the diurnal variation of potential gradient. Diurnal and seasonal variations also exist between potential gradient and air mass type, or amount of atmospheric pollution. Results of analysis, based on data obtained at Potsdam, Kew, in Saxony (Wahnsdorf) and in the mountains (Davos) shown in numerous graphs.

METEOROLOGICAL ABSTRACTS

551.594.12

2228. Variations of large ions in atmospheric air during disturbed weather conditions. R. SIKSNA. *Ark. Geofys.*, **1**, *Paper* 10, 237–46 (1950).

Measurements were made at Upsala, with an Israel large ion counter, of the variations in the numbers of large ions under various weather conditions. There was a large increase during a snowfall with large flakes, in a dry snowstorm, in continuous rain and in showers. There is a large increase prior to fog formation, a decrease during the fog, and an increase as the fog disperses. Correlations between the number of large ions, their spectra, the numbers of small ions and weather conditions are given.

R. S. READ

551.594.12

2229. Variations in the density of small-ions caused by the accumulation of emanation exhaled from the soil. H. NORINDER AND R. SIKSNA. *Tellus*, **2**, 168–72 (*Aug.*, 1950).

Observations indicate that the density of ions increases during meteorologically undisturbed summer nights. This typical increase is discussed and it is suggested that the probable cause is to be found in the accumulation of emanation exhaled from the ground. The accumulation occurs in weather situations which weaken or suppress convection. A.

551.594.12 : 622.8 : 621.317.3

2230. Measurement of atmospheric electricity in mines. L. FUNDER. *Arch. tech. Messen, Issue* 177 (*V*656–1) *T*113–*T*114 (*Oct.*, 1950) *In German.*

An instrument is described for the quantitative measurement of small ions (improved aspirator) and of large (heavy) ions; for the latter a larger condenser is added to the instrument. Characteristic properties of the instruments rendering them suitable for application in the mines are discussed. The atmospheric electricity is an important physiological factor and of great influence on the well-being of the miner. It is suggested that ionized air may have a relationship to pneumoconiosis and to firedamp explosions. Ionization intensities may be used as a guide in prospecting. W. SUMMER

551.594.51

2231. Evidence for the entry into the upper atmosphere of high-speed protons during auroral activity. A. B. MEINEL. *Science*, **112**, 590 (*Nov.* 17, 1950).

Spectra of the aurora of August 18–19 and August 19–20, 1950, taken with a spectrograph designed by the author, showed that the $H\alpha$ line was asymmetric to the violet when the spectrograph was pointed parallel to the magnetic field of the earth but not when the spectrograph pointed in a direction perpendicular to this field. The maximum violet displacement of the $H\alpha$ profile corresponds to a velocity of 2 800 km sec^{-1} and the author claims that this is the first evidence of protons of probable solar origin streaming into the atmosphere with speeds of this order. V. C. A. FERRARO

551.594.51 : 535.338.4

2232. New bands of N_2^+ in the infrared spectrum of the aurora. A.-B. MEINEL. *C.R. Acad. Sci., Paris*, **231**, 1049–50 (*Nov.* 13, 1950) *In French.*

Six red-degraded bands in the region 6 800–8 300 Å are assigned to a transition $A^2\Pi - X^2\Sigma$ in N_2^+. The constants of the $^2\Pi$ state are: $\nu_{0,0} = 10\,882{\cdot}6$, $A \sim 75$, $\omega_e = 1\,878{\cdot}4$, $x_e\omega_e = 16{\cdot}0$ cm^{-1}.

R. F. BARROW

551.594.51 : 551.593.9

2233. Aurora and luminous night clouds. J. PATON. Letter in *Proc. Phys. Soc., Lond. B*, **63**, 1039–40 (*Dec.*, 1950).

An account (with two well-reproduced photographs) of the very rare phenomenon of an auroral arc, and bright luminous night-clouds observed simultaneously in Central Scotland on the night of 24–25 July, 1950.

D. R. BARBER

551.594.6 : 538.566.2 : 621.396.11

2234. Radio echoes right round the globe. A.-H. DE VOOGT. *Onde Elect.*, **30**, 433–7 (*Oct.*, 1950) *In French.*

An attempt to explain why echoes received at the transmitter after a circuit of the earth are always 0·137788 sec after the pulse was transmitted independent of frequency and season. A mathematical theory for the time taken to traverse the world in a series of hops is given and this is applied to two

frequencies and three models of the ionosphere. For various angles of transmission the time taken is calculated and lies between 0·1455 and 0·1368 sec. The author concludes that the alternative theory of guided transmission in the ionosphere does not agree with observation and ends his paper by discussing the difficulties still remaining in explaining the observed phenomena. J. M. HOUGH

551.596 : 534.231

2235. Helmholtz waves in the atmosphere. D. J. BOUMAN. *Ned. Tijdschr. Natuurkde.*, **16**, 263–74 (*Nov.*, 1950) *In Dutch.*

A discussion, mainly theoretical.

E. P. WOHLFARTH

551.596 : 534.231

2236. Propagation of sound waves in the sea and in the atmosphere. J. VELDKAMP. *Ned. Tijdschr. Natuurkde.*, **16**, 281–9 (*Nov.*, 1950) *In Dutch.*

A review of theoretical and experimental work.

E. P. WOHLFARTH

BIOLOGY 57/59

577.3 : 539.16

2237. Bioelectric potentials as a measure of radiation injury. A. A. BLESS. *Proc. Nat. Acad. Sci., Wash.*, **36**, 617–23 (*Nov.*, 1950).

On the presumption that a relatively large number of measurements are taken, the bioelectric potential is as good a measure of radiation injury as any other parameters. A number of points are mentioned which influence the reliability of the measurements, e.g. temperature, age, radiation, intensity, etc.

W. SUMMER

591.18

2238. Some observations on biological noise. P. FATT AND B. KATZ. *Nature, Lond.*, **166**, 597–8 (*Oct.* 7, 1950).

A micro-electrode, inserted under motor nerve endings of a muscle fibre of the frog's extensor, can record small action potentials of rapid rise and slow decay, following one another at random intervals. They occur in discrete sizes, suggesting a number of units, discharging separately. They are abolished by curarine, and increased in size and duration by prostigmine. Small alterations in temperature and osmotic pressure appreciably affect the rate of discharge. These miniature end-plate potentials may be due to the random release of fairly large amounts of acetylcholine owing to the spontaneous fluctuations in the membrane potential of the individual nerve terminals. R. A. WEALE

MEDICAL SCIENCE. HUMAN PHYSIOLOGY 61

612.22 : 545.37

2239. A continuous flow respirometer utilizing the oxygen cathode. F. D. CARLSON, F. BRINK, JR. AND D. W. BRONK. *Rev. Sci. Instrum.*, **21**, 923–32 (*Nov.*, 1950).

612.825.55

2240. Neurophysiology of the auditory system. R. GALAMBOS. *J. Acoust. Soc. Amer.*, **22**, 785–91 (*Nov.*, 1950).

Describes the author's physiological experiments to elucidate the origins of the sensation of pitch and loudness. Diagrams are given indicating the "wiring" of the nervous system associated with hearing, and the use of glass micro-electrodes used to record the responses of single nerve units in the cochlear nucleus. Examples are given showing the inhibition of spontaneous single-unit activity in the cochlear nucleus by pure tone stimuli. The implications of these experimental results are discussed. A. B. WOOD

612.843

2241. The retinal receptors. H. HARTRIDGE. Letter in *Nature, Lond.*, **166**, 820–1 (*Nov.* 11, 1950).

A correlation is made between the maxima of absorption spectra of visual pigments on the one hand and Granit's [Abstr. 2336 (1943)] and Hartridge's [Abstr. 3028 (1946)] data on the other. A graph and a table but no new experimental results are provided. R. A. WEALE

612.843.2

2242. Properties of the human eye with respect to linearly and circularly polarized light. H. DE VRIES, R. JIELOF AND A. SPOOR. Letter in *Nature, Lond.*, **166**, 958–9 (*Dec.* 2, 1950).

612.843.2

2243. Macular pigment. H. HARTRIDGE. Letter in *Nature, Lond.*, **167**, 76–8 (*Jan.* 13, 1951).

It is suggested that the dark bands seen when one views the blue part of a spectrum, produced by a low-dispersion spectroscope [Keilin and Smith, *Nature, Lond.*, **143**, 333 (1939)], are due to the low sensitivity of [three?] special receptors responding to short wavelength radiations, and not to the presence of macular pigment. Lutein, present in the human fovea, is said to be the photo-catalyst for these receptors. R. A. WEALE

621.843.31

2244. Investigation of the colour vision of 995 individuals. G. N. RAUTIAN. *Dokl. Akad. Nauk, SSSR*, **74** (*No.* 6) 1073–6 (1950) *In Russian.*

612.843.31

2245. Some consequences of the additivity of luminosities. R. H. SINDEN. *J. Opt. Soc. Amer.*, **40**, 647–52 (*Oct.*, 1950).

Accepting the additivity of luminosities in spectral colour-mixture throughout a wide range of luminosities as an experimentally established principle, certain definite conclusions can be drawn concerning the constitution of the visual sensory mechanism. It is shown that a trisensational sensory system could satisfy the additivity of luminosities exactly only in the event of a direct-proportionality relationship

between visual sensation intensity and stimulus intensity, unless the luminosity coefficients of two of the three sensations were sensibly null. However, in a trisensational system in which sensation intensity obeys Fechner's law and more than one of the sensation luminosity coefficients has an appreciable value, the luminosity additivity law might hold to within the limit of observational error, but only if the spectral excitation curves of the elementary colour-sensations overlap much more extensively than has usually been assumed. The form of surfaces of constant luminosity in a colour-space representing a sensory system of the latter type is investigated. A sensory system in which luminosity is associated exclusively with a single element of the system would satisfy the additivity of luminosities unconditionally. A.

612.843.31

2246. On colour vision and its anomalies. A. POLACK. *C.R. Acad. Sci., Paris*, **231,** 1257–9 (*Nov.* 27, 1950) *In French.*

The trichromatic theory is said to be untenable because yellow, reputedly due to a mixture of the red and green sensations, can be experienced on stimulating the periphery of the human retina, whereas the latter two cannot. The abandonment of this theory requires a new nomenclature for the different types of defective colour vision, of which there are four. These are specified. Any number larger than four is due to "figments of the imagination." R. A. WEALE

612.843.31

2247. Subjective spectral band limits under controlled conditions. Z. V. HARVALIK AND J. H. BOWEN. *J. Opt. Soc. Amer.*, **40,** 755–6 (*Nov.*, 1950).

These have been established under controlled conditions as to dark adaptation of the eye, luminance of the spectrum (0·8 millilambert at 555 mμ) at the eyepiece slit, small visual angle (2·2°) of the slit, and observed bandwidth of 0·6 mμ at 400 mμ to 1·3 mμ at 700 mμ. 125 students have been subjected to the test. Colour-blind persons were excluded. The mean values of transition points established by these tests are as follows: Transition from infrared to red, 744 mμ; red to orange, 614 mμ; orange to yellow, 597 mμ; yellow to green, 582 mμ; green to blue, 514 mμ; blue to violet, 476 mμ; and violet to ultraviolet, 419 mμ. Colour transitions of some colour-blind subjects, exceptional subjects and subjects pre-exposed to various conventional light sources are also given. A.

612.843.32

2248. Spectral sensitivity of the receiving organs of the eye. E. N. YUSTOVA. *Dokl. Akad. Nauk, SSSR*, **74** (*No.* 6) 1069–72 (1950) *In Russian.*

612.843.32

2249. Spectral sensitivity of the eye for a given level of equivalent brightness. S. G. YUROV. *Dokl. Akad. Nauk, SSSR*, **74** (*No.* 6) 1077–80 (1950) *In Russian.*

612.843.37

2250. Threshold sensitivity of the rods and cones in the parafovea. J. CABELLO AND W. S. STILES. *An. Real. Soc. Esp. Fis. y Quím.*, **46A,** 251–82 (*Sept.–Oct.*, 1950) *In Spanish.*

The changeover from cone to rod vision is studied and the changeover point determined for an excitation $\lambda = 4\,900$ Å of low intensity. In various points of the scotopic field the effect has been studied which produces, at the threshold of 4 900 Å, a field of red adaptation with which one could arrive at very high intensities without exciting cone vision. In order to determine the point at which cone vision begins to appear, the directional sensitivity is made use of which, in general, is nil or much smaller for the rods, and greater and positive for the cones. By this means that part of the curve has been determined which is due to rods only. Two sensitivities of the rods have been found, namely one the reciprocal of the absolute threshold, the other the reciprocal of the field strength necessary to increase 10 times the value of the threshold or sensitivity in the retinal field. Three hypothetical explanations are given for this phenomenon. The curve representing cone vision has two branches which could be attributed to two cone mechanisms. The existence of two branches is contradictory to the results of the simple trichromatic analysis. W. SUMMER

612.843.53

2251. Recordings of scintillation. H. E. BUTLER. Letter in *Observatory*, **70,** 235–7 (*Dec.*, 1950).

Traces are shown of photoelectric recordings of the intensity-scintillation of Arcturus (elevations 1 and 8°), and Vega (75°), the beam-width being varied: the narrower the beam, the more marked is the undulation of the trace. R. A. WEALE

612.843.611

2252. The effect of intermittent preadapting light upon subsequent dark adaptation in the human eye. F. A. MOTE, A. J. RIOPELLE AND D. R. MEYER. *J. Opt. Soc. Amer.*, **40,** 584–8 (*Sept.*, 1950).

The influence of intermittent *v.* continuous preadaptation upon the dark adaptation of 3 subjects was measured for 9 brightnesses (8 860 to 22·15 ml) and 4 rates of interruption (2 cycles/sec to 1 cycle/4 sec). The data of the subjects were combined and the mean values used in the analysis of the results. The data are so nearly alike that it is considered there is no difference in subsequent dark adaptation which is related to the mode of preadaptation—for the durations of preadaptation used. No differences are found between any curve following intermittent preadaptation and its continuous control curve nor between the different curves for the various rates of interruption. A.

612.843.611 : 628.9

2253. Some remarks on the physiology of glare and vision under reduced illumination. H. GOLDMANN. *Bull. Ass. Suisse Elect.*, **41,** 751–60 (*Sept.* 30, 1950) *In German.*

A competent review of previous work on glare and adaptation is followed by the presentation of new data on the variation of form acuity with adaptation. Factors to be measured in the examinations of drivers, naval and air personnel are suggested and attention is to be paid both to glare and dark adaptation, preference being given to measurements of form acuity rather than those of absolute thresholds. 18 graphs and diagrams are given. R. A. WEALE

612.843.721

2254. The metric of binocular visual space. R. K. LUNEBURG. *J. Opt. Soc. Amer.*, **40**, 627–42 (*Oct.*, 1950).

Aims to show that the so-called visual space has a uniquely determined non-Euclidean metric, or psychometric distance function, the numerical parameters of which depend on the individual observer. Certain well-known phenomena of space perception, such as the horopter, the alley experiment and size constancy are explained on the basis of the distance function. Methods of measuring the personal parameters of the metric are developed, and applications of the theory to the field of binocular instruments and pictorial representation of space are suggested. A.

612.844.1

2255. The reactions of the crystalline lens in different persons treated by various mydriatics. J. MARANDON. *Rev. Opt.* (*Théor. Instrum.*) **29**, 580–93 (*Nov.*, 1950) *In French.*

The sensations of patients are described when they are under the influence of clinical doses of ephedrine, benzedrine, methedrine, adrenaline, homatropine, and atropine. Only adrenaline, homatropine and atropine are painless. Ephedrine and racemic methedrine have no effects on accommodation; benzedrine affects it slightly, the other drugs considerably. Homatropine is to be preferred to atropine as it interferes with accommodation only for one day. Tables, graphs and a bibliography are given.

R. A. WEALE

612.85

2256. Theory of operation of the cochlea: a contribution to the hydrodynamics of the cochlea. O. F. RANKE. *J. Acoust. Soc. Amer.*, **22**, 772–7 (*Nov.*, 1950).

A summary of calculations on the vibrations of the cochlear partition (basilar membrane). It is possible to determine the shape, velocity and amplitude distribution of the travelling waves running from the stapes to the inner ear. Furthermore, it is shown that the calculated vibration pattern is in agreement with observations made on the human cochlea and on models of human inner ears. In particular, analogies between the waves in the inner ear and on the seashore are pointed out. These analogies show the importance of the velocities of propagation for the excitation of the hearing nerve cells. A.

612.85

2257. Binaural localization and masking. W. E. KOCK. *J. Acoust. Soc. Amer.*, **22**, 801–4 (*Nov.*, 1950).

Binaural experiments are described which indicate that the ability of the brain to localize a desired sound and to suppress undesired sounds coming from other directions can be traced in part to the different times of arrival of a sound at the two ears. It is suggested that the brain inserts a time delay in one of the two nerve paths associated with the ears so as to be able to compare, and thus concentrate on, those sounds arriving at the ears with this particular time of arrival distance. The ability to perceive weak sounds binaurally in the presence of noise is shown to be a simple function of the direction of the desired sound and noise. An explanation is given for the effect reported by Koenig that front and rear confusion is avoided by head movements. A.

612.85

2258. Changes in pitch of tones of low frequency as a function of the pattern of excitation produced by a band of noise. J. P. EGAN AND D. R. MEYER. *J. Acoust. Soc. Amer.*, **22**, 827–33 (*Nov.*, 1950).

The excitation pattern of a tone is markedly altered by a masking stimulus. It should be expected that the pitch of the masked tone, as well as its threshold and its loudness, would be affected. In the present investigation the effect of a narrow band of noise (90 c/s wide, centred at 410 c/s) upon the pitch of pure tones of low frequency was measured in a series of experiments. Systematic changes in pitch were observed. The presence of the noise raises the pitch of a partially masked tone whose frequency is immediately above those of the band of noise. This change in pitch occurs even though the intensity of the masked tone is greater than that of the unmasked tone. In contrast, the presence of the masking noise lowers the pitch of a tone whose frequency is just lower than those of the band of noise, but this change is largely accounted for in terms of the intensity difference required for an equal loudness match. An attempt is made to account for the changes in pitch in terms of a place theory. A.

612.85

2259. Some electrophysiological correlates of the perception of successive clicks. M. R. ROSENZWEIG AND W. A. ROSENBLITH. Letter in *J. Acoust. Soc. Amer.*, **22**, 878–80 (*Nov.*, 1950).

Electrophysiological responses of the auditory nervous system were investigated in an attempt to get at physiological correlates for several phenomena of auditory perception. The perceptual phenomena include auditory localization, fusion of closely successive sounds, and time error (changes in the relative loudness of successive sounds). A.

612.858

2260. The time in which equilibrium state of audition is established. III. A new method of measuring the damping constant of the mechanical systems of the ear. Y. MAKITA AND S. MIYATANI. *J. Phys. Soc. Japan.*, **5**, 241–3 (*July–Aug.*, 1950).

See Abstr. 4570 (1950) for Parts I and II.

612.858

2261. Theory of the acoustical action of the cochlea. J. ZWISLOCKI. *J. Acoust. Soc. Amer.*, **22**, 778–84 (*Nov.*, 1950).

Describes the author's theory of the behaviour of the cochlea. The experimental results of von Békésy give good numerical proof of the essential assumptions and simplifications introduced into the mathematical analysis. A. B. WOOD

614.8 : 539.16

2262. Occupational radiation hazards. E. F. EDSON. *Brit. Med. Bull.*, 7 (*No.* 1–2) 57–63 (1950).

A survey of hazards arising from the use of ionizing radiation, in industry, medicine and research. Assuming median lethal dose LD_{50} for X- or γ-irradiation of total body volume of man is ~ 450 rep, the maximal radiation dose-rate $\not> 0{\cdot}5$ rep/week and maximal permissible body burden of Ra or Pu is $0{\cdot}1\ \mu g$; the methods of operation, training and the radiation and health supervision of personnel, to keep

below these dosage levels are detailed, and the medicolegal aspect is defined. T. A. CHALMERS

615.849 : 537.531

2263. The betatron in cancer therapy. H. E. JOHNS. *Nucleonics*, **7**, 76–83 (*Oct.*, 1950).

The application of a beam of X-rays from a 22 MeV betatron is described. Pb collimators define a beam of rectangular section 10×15 cm at a distance of 105 cm from the target. A Cu filter reduces the intensity along the axis of the beam and produces uniform intensity over the normal cross-section of the beam. A maximum dose is received at a depth of 4 cm inside the irradiated tissue and at 20 cm depth the dose has only fallen to 55% of this maximum value. L. R. SHEPHERD

615.849 : 539.16.08

2264. A simple radium detector for use on radium wards. J. VENNART. *Brit. J. Radiol.*, **14**, 12–13 (*Jan.*, 1951).

A neon lamp radium detector is described which will detect ½ mg of radium at distances in excess of 8 in. The correct functioning of the detector is checked by illuminating the detector lamp with the light from a second neon lamp in order to produce the same degree of ionization in the gas of the detector as is obtained when the radium is in the detecting position. A.

616.–073.75

2265. Physical measurements in routine clinical diagnosis with I^{131}. J. F. TAIT, J. R. COOK AND R. WORSNOP. *Brit. J. Radiol.*, **14**, 14–16 (*Jan.*, 1951).

It is stressed that in routine clinical diagnosis using I^{131} the drink should not be greater than 10 μc and that rapidity in carrying out measurements is important. Physical methods are described for meeting these more stringent requirements. Backscatter measurements are described which show that the backscatter factor in measuring thyroid uptake increases for Geiger counter cathodes of higher atomic number. A double counter arrangement is described for reducing geometrical variations of thyroid position with only a single measurement. A more sensitive γ-ray counting method for urine samples has been devised. A.

616.07 : 534.321.9

2266. Detection of intracranial pathology by ultrasound. H. T. BALLANTINE, JR., R. H. BOLT, T. F. HUETER AND G. D. LUDWIG. *Science*, **112**, 525–8 (*Nov.* 3, 1950).

Initial results are described on the application of ultrasonics for locating intracranial tumours. Measurements of the transmission in hog brain at frequencies of 1·25 and 2·5 Mc/s showed that the average attenuation in brain tissue containing white matter only was about 1·7 db/cm compared with 4 db/cm for the brain as a whole. The interposition of the ventricular system in the path of an ultrasonic pencil resulted in a 20 db increase in the energy transmitted; this was sufficient to indicate the position of the ventricles when the pencil was made to scan the brain. The correlation between X-ray and ultrasonic ventriculograms is described for the case of a formalin fixed brain. In living brains, the masking effect of reverberation upset the correlation, but by using a double-tank type of probe, useful indications of the position of the ventricular systems was obtained. By using intensities of less than 1 W/cm² at a frequency of 2·5 Mc/s, the patient did not experience pain. The great advantage of the ultrasonic method is that air injection of the ventricles is unnecessary.

H. J. H. STARKS

TECHNICAL MATERIALS 66/67

669

2267. Intermetallic compounds in ternary aluminium-rich alloys containing transitional metals. J. N. PRATT AND G. V. RAYNOR. *Proc. Roy. Soc.*, *A*, **205**, 103–18 (*Jan.* 22, 1951).

Assuming acceptance of electrons by the transitional metals to extents given by the vacancies in the "atomic orbitals" postulated by Pauling, it is found that the ternary compound of higher electron/atom ratio in the Al–Cr–Si system has a similar electron concentration to that of the ternary compound of lower electron/atom ratio in the Al–Mn–Si system. This behaviour is repeated for the systems Al–Mn–Si and Al–Fe–Si; in this case the compounds involved [α(AlFeSi) and α(AlMnSi)] are isomorphous and form uninterrupted solid solutions with each other. The compound of higher electron/atom ratio in the system Al–Fe–Si [β(AlFeSi)] has no counterpart in the Al–Co–Si system, but Co_2Al_9 dissolves Si until the electron/atom ratio is raised sufficiently to overlap the range of electron/atom ratios characteristic of β(AlFeSi). As the number of vacancies for electrons per atom of transitional metal decreases, the ternary compounds formed tend to move to progressively higher ranges of electron/atom ratio. These results are discussed in relation to previous work, and support the general hypothesis of acceptance of electrons by transitional metals. Of particular significance are the observations that Si and Ni both dissolve in Co_2Al_9 until the same maximum electron/atom ratio is reached; that α(AlMnSi) and α(AlFeSi) form uninterrupted solid solutions and, according to the hypothesis, have similar electron/atom ratios; and that structural relationships exist between various compounds whose electron/atom ratios are similar. A.

PHOTOGRAPHY 77

77.01

2268. Photographic field depth. R. BRUSCAGLIONI. *Atti Fond. "Giorgio Ronchi,"* **5,** 241–4 (*Oct.*, 1950) *In Italian.*

Assuming that the depth of the photographic field is limited by the planes for which the objective resolving power have a predeterminate value, formulae are deduced containing only the resolving power and the diameter of the diaphragm. The diagrams representing these formulae may be used for rapid calculations. A.

77.023.4 : 778.6

2269. Production of coloured photographic images by electrolysis or electrosynthesis. J. RZYMKOWSKI. *Sci. Ind. Photogr.*, **21,** 86–8 (*March*, 1950).

Previous publications are reviewed concerning the electrolytic production of oxidation-reduction systems in which the leuco-bases, because of their favourable potentials, act as good photographic developers in alkaline aqueous solutions, and the possibilities of obtaining coloured images by this method are indicated. Normally, the oxidized form is soluble in water, but in systems where it is insoluble it is deposited in the immediate vicinity of the reduced Ag and constitutes a secondary image. Reduction at the cathode of a mixture of phenol and nitrothymol or nitrocresol gives the reduced form of an indophenol which forms a good developer. The electrosynthesis is carried out in a glass vessel with an inner porous pot containing aqueous $MgSO_4$ as the anolyte. Immersed in the outer vessel, which contains the reactants dissolved in dilute K_2CO_3 solution, is a cylindrical Pb cathode. At the completion of electrolysis the product is transferred to a dish and used in the normal way. The insoluble oxidized form is deposited on the reduced Ag during development, forming an intensely blue secondary image which is evident after the removal of the Ag. PHOTOGRAPHIC ABSTRACTS

771.1

2270. Illumination of photographic darkrooms. G. WEBER. *Ingen. Vidensk. Skr.* (*No.* 1) 278 *pp.* (1950). Also published as monograph: *Copenhagen, The Academy of Technical Sciences and The Institution of Danish Civil Engineers* (1950) 278 *pp.*

After a general discussion of the problems of lighting photographic darkrooms, the author describes in detail the methods used and the results obtained in an exhaustive examination of the spectral sensitivity of photographic materials. The next two sections are concerned with the phenomena of vision and with photometry respectively. In the final section recommendations are made for darkroom lighting. White walls and ceiling are advocated and the illumination should be indirect from a fitting with colour filter. To cover the range of different materials, different colour filters and adjustable intensity are required. An extensive bibliography is given. J. W. T. WALSH

771.53

2271. Continuous method of preparation of photographic emulsions specially sensitive to ionizing particles. P. DEMERS. *C.R. Acad. Sci., Paris*, **231,** 616–17 (*Sept.* 25, 1950) *In French.*

A method of preparing emulsions for the recording of nuclear particles is described, in which the silver nitrate, potassium bromide, and gelatine solutions are run into a beaker continuously. The beaker possesses an overflow, and the solutions are fed in at a constant rate by means of "Zenith" stainless steel metering pumps. The emulsion grains are 0·2 to 0·4 μ in diameter; when sensitized with triethanolamine the emulsion is capable of recording electron tracks at energies down to 1·8 times the minimum ionization energy. W. F. BERG

771.53

2272. The role of sensitizing dyestuffs in the evolution of the photographic emulsion. J. D. KENDALL. *Photogr. J., A*, **90,** 341–6 (*Oct.*, 1950).

A historical survey (from 1873) which shows how the scope of photography has been widened and fundamental changes produced in the characteristics of the photographic emulsion. Some attention is also given to photography in natural colours and the manufacture of positive materials. A. HARVEY

771.534

2273. On a method for the calibration of photographic emulsions. D. G. KOWALEWSKI AND V. J. KOWALEWSKI. Letter in *J. Opt. Soc. Amer.*, **40,** 621–2 (*Sept.*, 1950).

771.535

2274. Role played by certain dyes in the action of infra-red on the latent image (Herschel effect). L. COHEN-SOLAL. *C.R. Acad. Sci., Paris*, **231,** 1136–8 (*Nov.* 20, 1950) *In French.*

The spectral region in which a latent image may be weakened appears to be extended by certain desensitizing dyes from the usual i.r. band towards shorter wavelengths, with a max. effect at $\sim$ 6 500 Å instead of $\sim$ 8 000 Å. It is considered that the same process occurs in undyed emulsions, but is masked by a small residual sensitivity on the long wavelength side of the main Ag halide absorption band, say between $\sim$ 4 500 Å and $\sim$ 7 000 Å. Dyeing removes this sensitivity and reveals the effect on the latent image. S. T. HENDERSON

771.535

2275. The effect of pressure and friction on photographic emulsions. A. C. MOORE. *Brit. J. Appl. Phys.*, **2,** 21–5 (*Jan.*, 1951).

The production of a latent image in photographic emulsions by friction, and the desensitization of the emulsions to subsequent illumination, both by friction and inhomogeneous pressure, has been investigated. It is suggested that the grains of Ag halide are deformed by pressure and form internal faults which act as latent image traps. This causes the desensitizing effect. If the forces are sufficient to shear the grains, then a latent image is formed which can be developed by an ordinary developer. The mechanism whereby this latent image is formed is not clear, but thermal effects probably play the main part. A.

772.1

2276. Growth of silver filaments and dendrites. C. R. BERRY. *J. Opt. Soc. Amer.*, **40,** 615–17 (*Sept.*, 1950).

Filaments and dendrites of Ag have been formed

by transfer of Ag through a layer of Ag halide which has been put in contact with a Ag block at about 400°C. According to the scheme proposed for explanation of the observations, Ag dissolves in the Ag halide and migrates as interstitial ions, transfer occurring because of the existence of a concentration gradient. At the same time vacant anion sites are formed in the reaction at the interface of the block and the Ag halide which permit the migration of halide ions towards the Ag block. When the rate of Ag migration is relatively slow, as with AgBr or AgCl, dendrites usually form by migration of Ag on the Ag already formed. When the Ag transfer is fast, as with AgI, the migration process does not remove the Ag quickly enough and the Ag is extruded as long filaments. A.

778.3

2277. Note on reduction of background fog in nuclear emulsion plates. P. K. S. WANG. Note in *Rev. Sci. Instrum.*, **21**, 816–17 (*Sept.*, 1950).

778.3

2278. Relativistic increase in ionization of charged particles in photographic emulsions. E. PICKUP AND L. VOYVODIC. Letter in *Phys. Rev.*, **80**, 89–90 (*Oct.* 1, 1950).

Using Ilford G5 plates the ionization of tracks was determined by grain counting and the energy of the particle by multiple Coulomb scattering. The experimental results seem to indicate a definite minimum in ionization followed by a plateau towards higher energies. The results are not sufficiently accurate to allow comparison with theoretical values. W. F. BERG

778.3

2279. On the thinning down of the tracks of heavy nuclei in the photographic emulsion. HOANG-TCHANG-FONG AND D. MORELLET. *C.R. Acad. Sci., Paris*, **231**, 695–7 (*Oct.* 9, 1950) *In French.*

A series of tracks of heavy nuclei terminating in photographic emulsions were analysed for the correlation between the length L of the thinning end portion and the atomic weight as determined by the number of δ-rays per unit length. According to the Bohr hypothesis [Abstr. 1488 (1949)], L should increase with the square of the atomic number, but the observations fit a linear law better. W. F. BERG

778.3

2280. A slide rule for nuclear emulsion calculations. A. BEISER. Note in *Rev. Sci. Instrum.*, **21**, 933–4 (*Nov.*, 1950).

778.3

2281. Double development of nuclear emulsions. C. JECH. Letter in *Phys. Rev.*, **80**, 759–60 (*Nov.* 15, 1950).

778.3

2282. Factors involved in the accuracy and reproducibility of depth measurements on nuclear research emulsions. J. M. MCALISTER AND D. W. KEAM. Letter in *Proc. Phys. Soc., Lond. A*, **64**, 91–2 (*Jan.*, 1951).

778.3 : 537.533

2283. A thermal mechanism for residual latent image fading in nuclear emulsions. A. BEISER. Letter in *Phys. Rev.*, **80**, 112 (*Oct.* 1, 1950).

778.3 : 539.165

2284. Grain counts and corrected α-particle range-energy curve for Ilford E-1 emulsions. I. B. BERLMAN. Letter in *Phys. Rev.*, **80**, 96–7 (*Oct.* 1, 1950).

778.3 : 539.166 : 537.542

Response of photographic emulsions to high-energy photons. *See Abstr.* 1878

778.3 : 539.17

2285. The identification of [nuclear] tracks finishing within emulsions sensitive to electrons. M. RENARDIER, H. MOUCHARAFIEH AND M. MORAND. *C.R. Acad. Sci., Paris*, **231**, 848–9 (*Oct.* 23, 1950) *In French.*

The charged particles producing developable tracks in photographic emulsions are often identified by the number of developed grains per unit length. This is not possible with highly sensitive emulsions, which produce almost continuous tracks with the more heavily ionizing particles. On tracks which run nearly parallel to the support, measuring the lengths of the gaps between the developed grains leads to similarly useful results. Curves are shown giving the percentage of the gaps as a function of the residual path length in the emulsion. The method is difficult to apply to tracks which are inclined to the support, since the shrinkage of the gelatine on drying and the projected view taken of the track make it difficult to assess the lengths of the gaps. W. F. BERG

778.3 : 539.17

2286. Energy losses of ionizing particles at relativistic velocities in the photographic plate. H. MESSEL AND D. M. RITSON. *Phil. Mag.*, **41**, 1129–32 (*Nov.*, 1950).

The relationship between grain density along the track of a relativistic particle in a photographic emulsion and the loss of energy of the particle in the Halpern–Hall model is examined. When account is taken of the limit of energy release in a single crystal of AgBr set by the size of the crystal, the total relativistic increase of grain density is found to be about 15%. It is concluded that existing grain counting results are not capable of detecting an effect of this magnitude. J. G. WILSON

778.33

2287. Radioactive microphotographs for resolution testing in autoradiography. G. W. W. STEVENS. *Brit. J. Radiol.*, **23**, 723–30 (*Dec.*, 1950).

Radioactive resolution test charts were prepared by the chemical toning of the Ag in minute photographic images. Conversion of the silver successively to AgBr and then to AgI could be effected with little loss of sharpness; the latter conversion was made with I^{131}. As the Ag images are confined to the emulsion surface and have a known distribution of radioactive material, examination of autoradiographs prepared from them permits a systematic experimental examination to be made of the factors influencing the resolving power of this technique. Tests on the influence of the type of the autoradiographic emulsion and its coating thickness are described. Moreover, the test charts can be supercoated with a gelatin layer of known thickness and then indicate how resolution is likely to suffer when the radioactivity is located below the surface of the histological specimen. A.

778.34

2288. Application of inflammable forms of phosphorus to photography in the infra-red section of the spectrum. Z. L. MORGENSHTERN. *Dokl. Akad. Nauk, SSSR*, **74** (*No.* 3) 493–5 (1950) *In Russian.*

The author, after stating that in 1945 and 1946 inflammable-phosphorus photographs of the mercurial spectrum were obtained by E. S. Krilov and W. Paul, describes the use for this purpose of inflammable alkaline-earth forms of phosphorus with 2 (Ce and Sm) activators. The method is illustrated by photographs of the mercurial spectrum and other spectra, for which the technical data are given and also by camera photographs in i.r. rays and by ordinary light of oil paintings. J. CLEUGH

778.38 : 53.087.5

2289. Precision methods of measurement employing photographic techniques. E. A. MISKIN. *Photogr. J.*, **90B,** 157–64 (*Nov.–Dec.*, 1950).

Methods of precision measurement using stereoscopic pairs of photographs are described in relation to scientific and engineering problems. Reference is made to the application of the Porro–Koppe principle of stereoscopic reconstruction as employed in certain plotting machines. The general principles of stereoscopic reconstruction are stated, and the importance of the base-distance ratio and the focal length of the camera lens are discussed in their relationship to accuracy of measurement. The conditions necessary in the inner and outer orientation of the cameras are given, and formulae to determine the probable error of measurement in the plastic image are stated. Use is made of macrophotography and microphotography for measurements to an accuracy of one micron. The relative affinities of microscope and plotting apparatus are discussed and a suitable method is given to enable plotting of microscopic objects to be carried out at a convenient scale. A.

778.6

2290. Natural colour photography in colloidal silver. R. D. BENSLEY. *Science*, **112,** 553–7 (*Nov.* 10, 1950).

Describes a recently patented process whereby a black-and-white photographic image in gelatin can be converted into a variety of colours of colloidal Ag, depending on the densities present in the material treated. The details given show that two negatives are necessary, one for the red end of the spectrum, the other for the blue. A print is made from one of these, then rehalided, exposed behind the other negative and redeveloped. A. HARVEY